Using an Online Course to Foster GIS
Knowledge in High School Students

By

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A thesis submitted to
the faculty of Graduate Studies and Research
in partial fulfillment of
the requirements for the degree of Masters of Arts
Department of Geography and Environmental Studies

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Using an Online GIS course to foster GIS
Knowledge in High School Students

Submitted by Samantha J. Baulch, B.A., B.Ed
in partial fulfillment of the requirements for
the degree of Masters of Arts

D.R.F. Taylor (acting chair) on behalf of Lisa Dally
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ABSTRACT

This paper examines the barriers to GIS education in secondary schools in North America. In particular it examines the case of Ontario, which has recently licensed the GIS program ArcView 3.x for all public schools. This paper establishes that lack of teacher knowledge in GIS and inadequate hardware is preventing the full implementation of GIS education and its associated pedagogical benefits. A solution to this problem is to develop an in-school online GIS course taught by trained teachers with skills in GIS education. Such a course has the ability to provide GIS education to students throughout Ontario as well as providing opportunities to learn in ways that are more difficult to achieve in the traditional classroom. To illustrate how an online GIS course could operate in the secondary school system, a portion of the Ontario grade 12 course, Geotechnologies in Action, has been developed.

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INTRODUCTION TO THE STUDY

INTRODUCTION TO THE PROBLEM AND CENTRAL ARGUMENT

The incorporation of Geographic Information Systems (GIS) into secondary level curriculum has become of interest to many educational and geographical institutions because of the pedagogical benefits associated with using a GIS. A GIS is "...defined as a combination of elements designed to store, retrieve, manipulate, and display geographic data – information about places. It is a package consisting of four basic parts: robust hardware, powerful software, special data and a thinking explorer" (ESRI White paper, 1998, p.2). Looking specifically at the case in Ontario, the Ministry of Education has made GIS a part of the grade nine Geography course: The Geography of Canada, which is a mandatory course to graduate. The Ontario Ministry of Education also offers two other courses that deal with GIS; the grade 11 course: The Geographer's Tool Kit and the grade 12 course: GeoTechnologies in Action.

Unfortunately, there is a significant lack of GIS education in Ontario schools, despite it being a component in a mandatory course and despite software, data and resources being freely available to schools. One reason for the lack of GIS education is the severe lack of funding faced by many school boards in Ontario.

At the start of the 2002-2003 school year, three major boards in Ontario (the Ottawa-Carleton District School Board, the Toronto District School Board and the Hamilton District School Board) faced massive deficits, as provincial funding did not meet their operating costs. In the Ottawa-Carleton District School Board this deficit resulted in a moratorium on teaching hiring, possible school closures, and a lack of computer funding. Since GIS systems need not only superior computers to operate, but also trained teachers, this often means that GIS cannot always be part of the curriculum. When schools do have adequate machines, the best of the machines usually go to departments that have traditionally been involved in computer technology, like the Math or Business department. Geography departments are left to share computer labs with History, English, French and a number of other departments. When teachers do obtain access to the labs, the computers are often more suited for word processing than using a GIS.

To further compound the problem there is a lack of new teachers graduating with GIS training and few teachers currently in the system who know how to operate a GIS or feel comfortable using a GIS. With little or no training offered to the geography teachers, GIS, even in schools that require it as part of their curriculum, is often not taught.

As both funding for educational institutions and trained instructors becomes harder to obtain, and as class sizes become increasingly larger, many institutions are

looking for alternate means to provide education. This pressure is also magnified by students' demand for education that prepares them for the new information and computer age. To face these challenges, educational institutions are experimenting with many different forms of educational delivery and are examining their accompanying pedagogy.

One of the most popular new forms of educational delivery is online learning. Online learning, which is also referred to as e-learning, distance learning over the net, and distributed learning, is a method of educational delivery where a student will take an entire course over the Internet. Since some of these terms also refer to Web-based materials delivered via CD-ROM or DVD, the term online learning will be used throughout this thesis since it refers specifically to learning over the Internet.

Online learning has gained unprecedented popularity among many different fields and disciplines, and Geography departments in post-secondary institutions have not been immune to this new form of educational delivery. One of the most popular courses to be offered as an online course by Geography Departments is GIS. One of the better-known institutions offering online GIS courses is UniGIS International (University Geographical Information Systems), which is a worldwide network of educational institutions who offer postgraduate certificates, diplomas or Masters courses in GIS. Some of the reputable institutions that belong to this organization include Simon Fraser University, the University of

Salzburg and the University of Southern California. Other institutions offering GIS courses exist, such as colleges, other universities, or GIS software companies (e.g. ESRI) who offer online learning courses for their software. The one area where online courses for GIS are not abundant is in secondary education.

Secondary schools have been slower to become part of the online learning movement, but over the last few years online secondary school courses have seen a rapid growth. The United States has been at the forefront of this movement with online schools like Kentucky Virtual High School and the Illinois Virtual High School. In Canada, Alberta hosts the majority of online learning in K-12 education, involving 4 700 full-time students and 4 000 part-time students in 19 programs across the province (<http://www.learning.gov.ab.ca/news/2001/October/nr-OnlineLearning.asp>). Ontario, has several boards experimenting with providing online learning, these include: the Toronto District School Board, the Ottawa-Carleton District School Board and the Durham District School Board. GIS, unfortunately, is not offered as a course at any of these online institutions, mainly because GIS is only slowly becoming part of the secondary curriculum in North America.

Online learning can be a possible solution to meet the needs of providing GIS education to secondary students. With the percentage of GIS trained teachers being small, most schools are not able to offer such dynamic courses as the

grade 11 Geographer's toolkit course or the grade 12 Geotechnologies in Action course. Providing courses like these in an online environment makes them more accessible to students across the province. Online learning can also solve the problem of inadequate computer labs for GIS education. While most schools are unable to reserve a full lab of adequate computers for one class, they are more likely to be able to offer students (especially senior level students) an adequate computer either in the library or within another classroom.

Using online learning to teach GIS to secondary students also has the potential to teach in ways that can be difficult to achieve in the traditional classroom. The most often cited benefit of online learning is that it appeals to a learner's multi-sensory ability, encouraging the learner to be an active rather than a passive learner (Freundschuh & Hellevik, 1999). GIS, because it is a decision making tool, is better suited in situations where students are active and independent learners. Thus, online learning with GIS is a perfect marriage for not only developing independent learning but also for providing GIS education to all students.

Online learning is considered to be useful for different learning styles, thus helping to increase students' knowledge of course material (Lemke & Ritter, 2000). The different learning styles refer to Howard Gardner's research into the way people learn and perceive the world. In the early 1980s, Gardner questioned the typical uniform style of teaching and conducted research in learning. From this research he developed seven different learning styles and

suggested ways that educators can approach them. These styles, which he refers to as multiple intelligences, are:

Musical intelligence: “the capacity to think in music, to be able to hear patterns, recognize them, remember them, and perhaps manipulate them” (Checkly, 1997, p.5)

Bodily-Kinesthetic intelligence: “the capacity to use your whole body, or parts of your body – your hand, your fingers, your arms – to solve a problem, make something or put on some kind of production.” (Checkly, 1997, p. 5)

Logical – Mathematical intelligence: “the ability to understand underlying principles of some kind of a casual system, the way a scientist or logician does; or can manipulate numbers, quantities, and operations, the way a mathematician does” (Checkly, 1997, p. 5)

Linguistic intelligence: “is the capacity to use language...to express what is on your mind and it understand other people” (Checkly, 1997, p. 5)

Spatial intelligence: “refers to the ability to represent the spatial world internally in your mind” (Checkly, 1997 p. 5)

Interpersonal intelligence: “is understanding other people. It’s an ability we all need, but is at a premium if you’re a teacher, clinician, salesperson, or politician” (Checkly, 1997, p. 5)

Intrapersonal intelligence: “refers to having an understanding of yourself, of knowing who you are, what you can do, what you want to do, how you react to things, which things to avoid, and which things to gravitate toward” (Checkly, 1997, p.5).

The central argument presented in this thesis is that the development of an in-school online GIS course for secondary school students has the potential to not only provide GIS education, but to also improve on what is currently available. It will be argued that this type of course is necessary in light of the current deficiencies in resources and trained GIS teachers in the school system. It will

also be argued online learning has the ability to teach and to learn in ways that can be challenging to emulate in the traditional classroom. To support these arguments a portion of the Ontario grade 12 course: Geotechnologies in Action will be developed into an in-school online course. While this course focuses on all the facets of Geomatics (GIS, Remote Sensing, Cartography, Land Surveying, Global Positioning Unit), only the GIS component will be fully developed.

ORGANIZATION OF THE PRESENT STUDY

This thesis will be organized as follows:

Chapter One

“An Overview of GIS Education in North America” will be a brief outline of the history of GIS in both post-secondary and secondary institutions, teacher attitudes towards GIS education, and secondary schools ability to provide a GIS education.

Chapter Two

“A History of Online Learning” will provide a brief history of online learning in secondary schools and online GIS courses. This is to illustrate where online GIS courses have come from and where they can go.

Chapter Three

“The Traditional Classroom Versus the Online Classroom” will examine online learning versus traditional classroom learning as a method of pedagogy.

Chapter Four

“Design of the Online Classroom” will examine various different designs in online learning and examine which one meets the needs of a secondary school GIS course.

Chapter Five

“Geotechnologies in Action: An Online GIS Course” will examine the course the author has designed and question whether or not it is a feasible creation for a secondary school teacher.

Chapter Six

“Conclusion” will conclude the thesis and point to the need for further research

The online course will be created using the following software:

- Macromedia’s Dreamweaver 4, a dynamic Web page creation program
- Macromedia Flash 5, a Web-animation creation program.
- Adobe Photoshop 5.5, a graphic creation program

While the Ontario Ministry of Education does not license these exact programs, similar versions have been licensed. The final software program used in the course is a *shareware* screen capture program, called Hypersnap-DX 5. Shareware is software that is either distributed free on a trial basis with the understanding that the user will have to pay for it later or distributed free with certain capabilities missing.

Part of this study will also determine whether or not it is possible for teachers to create a well-designed online course using software that is available to them through the Ontario Ministry of Education or free sources.

The GIS program to be used in this prototype course is ArcView 3.x for Windows computers. The Ontario Ministry of Education has licensed ArcView 3.x for both Windows and Mac computers. The data to be used in this prototype course is ArcCanada 2.0, which has also been licensed by the Ontario Ministry of Education.

METHODOLOGY

In order to provide a detailed discussion of online learning of GIS in Secondary Education, the following primary and secondary research methods were employed:

- A comprehensive review of the published literature, including academic journals, professional newsletters, textbooks and M.A. and Ph.D. theses;
- Identification of, and communication with, various individuals (including educators, researchers, representatives of GIS software companies) who are currently involved with either GIS education or online learning, and
- A comprehensive World Wide Web-based review of online GIS programs, online high schools and teacher education programs offered at the Faculties of Education throughout Ontario.

In order to provide an overview and partial online course design of the grade 12 Geotechnologies in Action, the following primary resources were employed:

- Consultation with individuals currently teaching Geotechnologies in Action or who are involved in teaching GIS in a high school setting;
- Consultation with individuals currently teaching in online courses to high school students;
- Consultation with Carole Dence, Director of Carleton University's Teaching and Learning Centre;
- Consultation with Annette Levesque, Online Teacher with the Ottawa-Carleton District School Board;

- Consultation with Erin Kelly, K-12 Industry Manager with ESRI Canada;
- Consultation with Jessica Goerz, Educational Technology Leader, Business and Learning Technologies, Ottawa-Carleton District School Board
- Consultation with Tim Hawes, Secondary Schools Consultant, Business and Learning Technologies, Ottawa-Carleton District School Board
- Consultation with Charlotte Lauerman, K-12 Online Curriculum Instructor, University of Montana
- The author's own observations while teaching GIS to secondary school students and to secondary school teachers in the Ottawa Carleton District School Board;
- The author's own experiences as a Geography teacher with the Halifax Regional School Board, and
- Partial creation of an in-school online course for the grade 12 Geotechnologies in Action course, according to the curriculum guidelines established by the Ontario Ministry of Education.

LIMITATIONS OF THE PRESENT STUDY

While this thesis will examine the situation of GIS and online learning throughout North America, due to the need to limit this study, this study will examine the design of a course for implementation into the Ontario curriculum. Specifically, this paper will focus on designing an online course for the grade 12 Geotechnologies in Action course. While creating a course that can be used in

other provinces or states may be more universally beneficial, Ontario has an advantage over many of these jurisdictions as the GIS software and data needed for the course is licensed and the curriculum expectations have already been developed for this course. This obviously makes the implementation of an online course easier.

Since the Ontario Ministry of Education has established the curriculum for Geotechnologies in Action, this study will not discuss GIS or Geomatics curriculum.

To further limit the scope of the study, it will not examine gender or cultural differences in online learning or GIS education. The present study will also not use a user group to test the online course created which is beyond the scope of this thesis.

The online course developed is intended to be used by students in their secondary schools during regular school hours and is not designed as a course that can be taken at home. The license agreement the Ontario Ministry of Education has with ESRI prohibits students from installing ArcView 3.x or the data CD ArcCanada 2.0 onto their home computer for educational purposes. The cost of this software and data also prohibits many students from installing it at home. Use of in-school online courses has been experimented with in the

Ottawa-Carleton District School board with good success. The use of an in-school online GIS course has also met success in the United States.

This study will also not examine rubrics, a guideline for rating student performance. While used in the new curriculum by teachers throughout the province of Ontario, their creation involves considerable effort and could constitute a thesis in their own right.

A final limitation of this study is that the full course for Geotechnologies in Action will not be developed. This is due not only to the amount of time involved in creating lessons from 'scratch' but also because the amount of time involved to develop these lessons into an online course. As will be discussed later in this thesis creating effective online courses is a labour intensive and time consuming business.

CHAPTER ONE

AN OVERVIEW OF GIS EDUCATION IN NORTH AMERICA

INTRODUCTION

GIS education is only slowly moving into K-12 education, despite the many positive pedagogical effects it has on classroom teaching and learning. While classroom use by teachers is small, even in Ontario where GIS software and data is freely available, most teachers do express positive perceptions of it (Audet & Paris, 1997; Lemberg & Stoltman, 1999; Meyer et al, 1999). The lack of inclusion is mainly a result of inadequate hardware and limited training opportunities for teachers. These issues will be discussed by looking at GIS education, teachers' perceptions towards GIS and secondary schools' ability to support GIS education.

HISTORY OF GIS EDUCATION

Forty years have passed since the advent of the first GIS, created in 1963 by Dr. Roger Tomlinson, which was created to link digital maps with textual information to help with decision-making problems. Subsequent research, conducted at the Harvard Lab for Computer Graphic and Spatial Analysis established GIS as a viable technology in decision-making with spatial issues. During these early

years of GIS technology, usage was limited to a restricted group of highly trained users, or to universities that could afford the technology (Storie, 2000). Due to these restrictive factors, many GIS users were self-taught. However, with the decrease in the cost of technology and the demand for GIS trained professionals, courses began to appear in geography and associated disciplines throughout North America approximately 20 years ago (Deadman et al, 2000). Over the next two decades, GIS gained in popularity and is now firmly established throughout universities and colleges in the developed world. An examination of calendars for post-secondary institutions reveals that it is now possible to obtain anything from a certificate to a B.A. or an MSc in GIS.

GIS has penetrated well beyond post-secondary institutions and is now a part of the curriculum in K-12 education in many school districts throughout North America (Deadman et al, 2000). In Canada the situation is:

British Columbia: licensed ArcView 3.2 and ArcCanada 2.0 (data for Canada and the world) for all elementary and secondary schools

Alberta: two Forestry classes offered at the secondary level require a GIS component

Ontario: licensed ArcView 3.2 (for PC), ArcView 3.0 (for Mac) and ArcCanada 2.0 for all elementary and secondary schools. It has also licensed MF Teach for all elementary and secondary schools. Requires that grade nine geography students learn geographic skills through using a GIS. Has incorporated a grade 11 and a grade 12 geomatics course

Nova Scotia: licensed ArcView 3.2 (for PC), ArcView 3.0 (for Mac) and ArcCanada 2.0 for all elementary and secondary schools.

Many of the other provinces are currently producing curriculum that includes a GIS component (Kelly, 2002). For example, the Alberta government is

introducing GIS from grade four to high school starting in 2007, the Nova Scotia government is currently creating curriculum for a grade 12 geomatics course and the Manitoba government is making reference to it in its social studies and science curriculum (Shirley Douglas, 2002; Wayne Hamilton, 2002; Diane Cooley, 2002).

The inclusion of GIS in K-12 has been a prevailing interest of universities, researchers, industry and geographic associations throughout the 1990s and can be illustrated by the numerous meetings and sponsored staff development programs (Bednarz, 1998). Beginning in 1993, the National Science Foundation of the United States established a conference focused on the topic, this was followed by a meeting in 1994 organized by the National Center for Geographic Information and Analysis (NCGIA). In the summer of 1998 an institute funded by the National Council for Geographic Education and the Geography Educational National Implementation Project trained 32 K-12 geography teachers in GIS. Private industry has also been involved in promoting GIS education through meetings, for example in 2001 ESRI began an annual Education User Conference for K-12 through University. But perhaps the most well known program for encouraging GIS into K-12 education is GIS Day. Held every November since 1999, this event encourages users and vendors to open their doors to schools and the public to promote awareness, use and education of GIS. Part of this program's success stems from the many high-profile sponsors involved, including: the National Geographic Society, the Association of

American Geographers, the University Consortium for Geographic Information Science, the United States Geological Society, the Library of Congress, Sun Microsystems and ESRI.

Further encouragement of GIS in K-12 education can be seen in the variety of papers written extolling the benefits of GIS in the classroom (Sui, 1995; Lemberg & Stoltman, 1999; Baker, 2000; Fitzpatrick et al, 2000). ESRI has also been heavily involved with encouraging GIS in K-12 education with the publication of a White paper in 1995, which was later revised in 1998. Perhaps, however, the catalyst for incorporating GIS into K-12 education came in 1994 with the publication of the *National Geography Standards* by the American Geographical Society, the Association of American Geographers, the National Council for Geographic Education, and the National Geographic Society. The National Geography Standards, adopted by many boards of education for Geography curriculum, specifically encourages the inclusion of GIS in K-12 education (Bednarz & Audet, 1999). However, the standards note that while GIS will play an increasingly important role in geographic education, they also understand that GIS is being gradually adopted into schools and therefore, "the standards were written with geographic information systems in mind but not immediately in sight...We have illustrated the possibility of its use in some examples of things that students and teachers might do" (Geography Education Standards Project 1994, 257). The standards optimistically state that GIS will play an increasingly important role in K-12 education over the next 10 years. While GIS education

has increased over the past eight years since the Standards were written, there is definite room for improvement.

The push to include GIS as part of the K-12 curriculum partly stems from the need for GIS professionals in the business world. Worldwide, the number of professionals using GIS as part of their job is approaching one million, with approximately 500 000 people using it in the United States (U.S.). Of this number, 50 000 professionals in the U.S. use GIS on a full time basis, and this number continues to grow at 15% per year. Given these figures there is a need for 7 500 GIS trained graduates per year in the U.S., unfortunately, universities and colleges in the U.S. only turn out 4 000 graduates every year (Fitzpatrick et al, 2000).

The demand for GIS professionals is obviously very intense, and the situation in the U.S. can also be found here in Canada. A recent study completed by the Canadian Council of Land Surveyors, in partnership with the Canadian Institute of Geomatics, the Geomatics Industry Association of Canada and Human Resources Development Canada found that the Geomatics industry is expected to grow from 27 000 people in 2001 to 32 000 by 2004 (Canadian Council of Land Surveyors, May 2001). To meet the needs of the business world, universities and colleges are promoting GIS education not only at post-secondary level, but also at the secondary level. Many administrators at universities and colleges wisely recognize that "...students who gain familiarity with technology

and its applications in the early grades will be more inclined to learn and use technology in later schooling and in adult life. While the purpose for using technology is to advance academic knowledge, awareness of career opportunities in science and technology are likely spin-off benefits” (Lemberg and Stoltman, 1999, p.65). Introducing GIS at K-12 will likely improve enrolment in GIS courses at the post-secondary level, thus meeting the need for GIS professionals in the business world.

PEDAGOGICAL BENEFITS OF GIS IN THE K-12 CURRICULUM

Inclusion of GIS into K-12 education is not just about meeting the needs of industry, GIS also has some useful pedagogical aspects. One of the most cited ones is that it emphasizes a hands-on, research based learning experience which is ideal for the development of advanced problem solving skills (Goodchild, 1993; Audet and Abegg, 1996; Baker, 2000). Researchers have also argued that a GIS is an excellent tool for developing spatial reasoning, and many argue that GIS may be seen as the facilitator for maximizing students’ understanding of spatial processes (Donaldson, 1999). Because of the advantages that GIS offers to students at the secondary level, many researchers have studied how GIS can benefit the present curriculum. The ultimate goal of this research is to encourage the adoption of GIS into the K-12 education.

Sui, (1995) took the five themes of Geography, which are included in the National Geography Standards, and illustrated how GIS can be used with these themes.

These five themes of geography have been the basis of many geographic curricula throughout North America, including Ontario's.

1. Location
Refers to one's position on the earth. GIS can illustrate location through interactive maps using various levels of scale.
2. Place
Refers to the physical and human characteristics that give a sense of place. GIS can show the location, size and proximity of physical characteristics (i.e. mountains) and human characteristics (i.e. cities)
3. Human/Environment Interactions
Refers to the positive and negative effects of humans interacting with their environment. A GIS can be used as a visualization tool to show the effects of human interactions like forestry and urban encroachment.
4. Movement
Refers to the way people interact (i.e. travel and communication) with people and places around the world. A GIS can illustrate this theme by showing highways connecting major cities.
5. Regions
Refers to how the world is divided up. Using a GIS a student can look at the various scales of a map to see how the world is divided up into physiographic regions to subdivisions in a city.
(Sui, 1995)

ESRI has also illustrated ways in which GIS can be beneficial to K-12 education.

In ESRI's "GIS in K-12 Education: An ESRI White Paper", eight ways are listed, these are:

1. "GIS can play a role in educational reform"
GIS is seen as an effective tool for promoting intellectual growth for students and teachers. For students it is seen as an excellent means to developing independent thinking skills, for exploring alternative responses to problems and for becoming more involved as local and global citizens. For teachers it is seen as a means for effective change in instructional methodology since the software and data do not provide the answer for students. Teachers are therefore forced to allow students to explore answers at their own learning pace.

2. "GIS is a vocational tool"
A GIS is an excellent tool for providing training for many careers, especially since the demand for GIS professionals is increasing every year. A GIS is also viewed as a flexible tool for developing basic computer literacy skills.
3. "GIS engages and exercises multiple capacities and intelligences"
A GIS suits the needs of many of Howard Gardner's multiple intelligence theory. Specifically, it is highly suited for those who are logical mathematical, linguistic, spatial and interpersonal.
4. "GIS relies on and fosters a mindset of explanation"
Using GIS encourages students to solve problems by exploring multiple scenarios. GIS helps facilitate this by providing visualization of alternative answers.
5. "GIS relies on and promotes finding information and knowing what to do with it"
A GIS teaches students to recognize appropriate types and sources of information. It also facilitates skills in matching data with tasks.
6. "GIS relies on and promotes spatial awareness"
Using a GIS encourages students to recognize landscape and symbolic patterns, to describe and explain spatial patterns and to identify patterns and processes.
7. "GIS relies on and promotes computer literacy"
Among many skills, students using a GIS develop skills in graphic tool use, producing multimedia projects and database management.
8. "Using GIS effectively requires knowing how to make the GIS software perform particular tasks"
A GIS is a complex but flexible tool. Therefore, learning to use a GIS will teach students to understand which tools fit which tasks. It will also provide students with techniques for learning and using other software programs.

However, it should be noted that there are many barriers to using a GIS in the classroom, which must be overcome. Audet and Paris (1997) state "even when the benefits of an innovative practice are recognized, the motivation to change may dwindle if a teacher encounters major difficulties during implementation"

(Audet & Paris, 1997, p. 294). A positive teacher attitude towards GIS is, therefore, essential if it is to be taught at all. If teachers feel that they are entering unfamiliar teaching territory because of GIS or because of the pedagogy behind teaching a GIS, its use in schools may be limited. This would be disappointing since today's information age requires our students to be independent learners with competent computer skills, and GIS is a unique and beneficial tool to achieve this goal.

TEACHERS' ATTITUDES TOWARDS GIS IN THE CLASSROOM

Throughout Ontario, and the rest of North America, GIS in K-12 education stretches across a spectrum of integration. At one end GIS has been highly integrated into the classroom as both a teaching aid and a subject, and at the opposite end GIS is simply mentioned to the students as an existing system of software. While studies (Audet & Paris, 1997; Meyer et al, 1999) have indicated that teachers' attitudes towards GIS are positive, most integration of GIS resides in the lower end of the spectrum. A recent study conducted by the National Center for Geographic Information and Analysis (NCGIA) examined teachers' perception of the potential of GIS in the classroom (Lemberg & Stoltman, 1999). The study involved providing teachers with weeklong educational workshop on GIS. The survey at the end of the workshop showed that teachers saw positive roles for GIS in promoting problem solving, project management, group participation and computer technology skills. Another study conducted by Meyer et. al. (1999) trained 13 teachers to use GIS over a two-week period in the

summer. This course provided the teachers with time to develop curriculum, using GIS, for the courses they would be teaching in the following school year. The teachers surveyed all saw the pedagogical benefits of implementing GIS into their curriculum, however, of the 13 teachers trained only six actually used GIS in their classes, and of these six very few went beyond a demonstration of a GIS. While teachers' attitudes towards GIS are positive, its inclusion in the curriculum is slow, despite the obvious advantages of incorporating it.

SECONDARY SCHOOLS ABILITY TO SUPPORT GIS

GIS is not being incorporated into classroom lessons despite the many pedagogical benefits associated with it and despite strong teacher perceptions towards its use. Researchers who have examined this issue (Donaldson, 1999; Meyer, 1999) point out that unfortunately secondary schools are not prepared to meet the needs of teaching with a GIS. These studies conclude that hardware equipment, lack of GIS knowledgeable teachers and insufficient GIS software and data present major barriers to using GIS in the K-12 curriculum.

The Meyer et. al. (1999) study (as described in the previous section) noted that despite positive teacher attitude towards GIS, few of the 13 teachers trained in GIS use incorporated it into the classroom because of the inadequate computer hardware available.

A recent study (Donaldson, 1999) conducted on the ability of secondary schools in the state of Ohio to use GIS show there is a lack of sufficient computer hardware. For a GIS, like ArcView, to operate superior computers are needed. ESRI's White paper on GIS in education states the following requirements are needed for the ArcView software:

Windows:

Pentium or higher running Windows 95/98 or Windows NT

Macintosh:

Power Macintosh or higher running OS 7.1 or higher

Other requirements:

32+ MB of RAM

100+ MB dedicated to the GIS

CD-ROM drive

256+ colour monitor

Mouse

Colour printer

(ESRI, 1998, p. 3)

In Donaldson's study, of the 120 school respondents, 40% of the schools did not have the computer hardware infrastructure to support school wide GIS implementation.

In the Ottawa-Carleton District School Board (OCDSB) the majority of the secondary schools have set up several computer labs for school wide use. However, geography teachers do not always have access to the best labs containing superior computer equipment, as these labs are usually reserved for classes in computer programming or multimedia classes. Geography teachers are usually forced to share a common lab with other departments, which often

contain older and less reliable equipment. Geography teachers are given these labs because they have traditionally booked few classes in them. With the inclusion of GIS into the curriculum, geography teachers are using the labs more often, and are unfortunately finding the inadequate computer hardware a major barrier to the implementation of GIS into their courses. Having taught GIS in the majority of the secondary schools in the OCDSB, this author can attest to the frustrating experience for both students and teachers when the equipment is not functioning properly. Students who are used to their more reliable home computers become very frustrated when it takes five minutes to perform a task that usually takes only five seconds on other computers. This, unfortunately, has harmful repercussions as students will leave the learning session with a negative opinion about GIS. From a teacher's perspective, classroom management becomes difficult when faced with a room of disgruntled and frustrated teenagers. It is also exasperating to teachers when they are forced to deal with computer problems rather than teach. Researchers, (Meyer et. al., 1999) have cited the lack of adequate computer hardware as the number one reason why teachers, especially GIS trained teachers, do not use GIS. With recent developments in the education budget in Ontario, it is unlikely that geography teachers who are faced with inadequate computers will be getting new ones in the near future.

An in-school online course can obviously solve the issue of the lack of adequate hardware. Students can register for the course like any traditional high school

course, but instead of a whole lab being booked for a few students, the online student can use a computer in the library, which are often superior to those typically available for geography teachers. They can also use a better computer in the better equipped multimedia or computer programming classrooms. From the author's experience, class sizes are often small for these classes and there should be a computer free for a student to use. Students could also use an available computer during lunchtime, when no classes will be scheduled for that computer lab.

GIS software is often very expensive for schools, particularly since many of them are facing decreasing budgets. To adequately use GIS software, data is also needed which can be costly. Many sources of free data do exist, but this requires time and energy on the teacher's part to find the sources for this free data and determine not only its usefulness but also its accuracy (Parmenteer & Burns, 2001). For the Canadian teacher finding free data that is useful and accurate it is particularly challenging because of the Canadian government restrictions on publishing geographic data. However, this is changing as a result of new programs such as GeoGratis. ESRI Canada provides a site licence for ArcView and 8 CDs containing data for \$825 CDN (<http://www.esricanada.com/k-12/index.html>). Under the licence agreement ArcView and the data can be installed on as many computers as desired within the school. While \$825 is a low cost for what is normally priced at \$3500 CDN, many schools may find this costly in light of budget constraints and the need to buy textbooks. To increase

the use of GIS in Ontario, the Ministry of Education has negotiated a licence with ESRI Canada making the software and much of the data free for both elementary and secondary schools. Thus, Ontario schools have an advantage over schools in other areas in using GIS.

Lack of teacher training in GIS is also cited as a major barrier to implementing GIS in the K-12 curriculum. Researchers (Lemberg & Stoltman, 1998; Bednarz & Audet, 1998) have noted there is a lack of commitment by universities to teaching GIS to *pre-service* geography teachers. Pre-service teachers are those enrolled at a faculty of Education and are learning to become teachers. In a recent study (Bednarz & Audet, 1998) teacher education programs in the United States were surveyed about their commitment to teaching GIS. Of the 253 respondents, only 26 said that GIS was part of the their teacher education program. In Ontario, where GIS is part of the mandatory geography curriculum, GIS training to pre-service geography teachers is lacking. If GIS is taught to pre-service teachers it is mainly to show that this technology exists. Instruction on how to use a GIS or more importantly how to incorporate it in a classroom is virtually non-existent across the Faculties of Education in Ontario. To obtain information about the GIS component in geography curriculum classes at Ontario's Faculties of Education, Websites were examined and professors were contacted. Course descriptions for both intermediate-senior geography curriculum classes and for junior-intermediate geography curriculum classes were examined, as this is the most likely place that GIS will be taught.

The lack of training in GIS for pre-service geography teachers is evident by looking at table 1.1. Of those courses that state GIS will be used, this most often consists of a single presentation where GIS is demonstrated.

Some may argue that many geography teachers take GIS as part of their undergraduate program, but those students who graduate with a firm knowledge in GIS tend to pursue careers in that profession, rather than teaching. As most Bachelor of Education programs require only two to three undergraduate courses in a subject for a high school 'teachable', the chances that one of these courses is a GIS course is quite slim. From the author's experience as an education student, many geography education students have not taken a GIS course as geography is a popular choice for those looking for their second minor teachable (since most Bachelor of Education Intermediate-Senior programs require two teachables), especially for those involved in physical education or the life sciences. This often means that many of the geography teachers entering into the work force are not 'geographers' and would therefore have even less exposure to GIS than those who did a major in geography. For example in Donaldson's study he examined how many of the teachers in the respondents schools in Ohio were familiar with GIS. Only 18% surveyed were familiar with GIS, and of these only 3% used it in the classroom (Donaldson, 1999).

Table 1.1 GIS training at Ontario Faculties of Education¹

Faculty of Education	Courses	GIS training in geography curriculum classes
Brock University	J/I Geography*	Course makes no reference to GIS. However the professor of the course provides students with a 20 minute demo of GIS during a visit to Brock's Map Library (David Hutchinson, email to the author)
	I/S Geography**	Brock does not offer a Bachelor of Education in I/S
Lakehead University	4252 Geography (J/I)	Course description makes no reference to GIS
	4263 Geography (I/S)	Course description makes no reference to GIS
Laurentian University	EDUC 4224 (J/I)	Course description makes no reference to GIS
	EDUC 4329 (I/S)	Course description makes no reference to GIS
Nipissing University	Geography J/I	Course description makes no reference to GIS
	Geography I/S	Course description makes no reference to GIS
Queen's University	Geography J/I	Queen's does not offer a Bachelor of Education in J/I.
	Curr 323 (I/S)	Course description makes reference to GIS by stating the course "includes a lab component to provide hands-on experience in the use and application of computers and GIS software packages appropriate for grades 7-12" (http://edu.queensu.ca/programs/pages/b.ed/courses/curr.html#323).
University of Ottawa	PED2141 – Social Studies (J/I)	Course description makes no reference to GIS
	PED4280 – Instructional Strategies in Geography (I/S)	Course description makes no reference to GIS. However, according to the professor of the course, this will consist of a presentation on GIS to the students (Baker, 2002).
University of Toronto	Geography Intermediate EDU1441 (I)	Course description makes no reference to GIS
	Geography Intermediate-Senior EDU1440 (I/S)	Course description makes no reference to GIS
University of Western Ontario	Teaching and Learning Theory in Intermediate/Senior Geography 32 (I/S)	Course description makes reference to GIS by stating "a focus on curriculum design and approaches to teaching and learning including use of geotechnologies" (http://www.edu.uwo.ca/preservice/coursedescript/reqC_inter_senior.html).
	Geography in the Elementary School 24	Course description makes no reference to GIS
York University	ED/GEOG 3040 3.0 Teaching Geography in the Intermediate Division	Course description makes no reference to GIS
	ED/GEOG 3050 3.0 Teaching Geography in the Senior Division	Course description makes no reference to GIS

- *Junior-Intermediate (J/I) courses are designed for pre-service teachers of grades 4 to 10
- **Intermediate-Senior (I/S) course are designed for pre-service teachers of grades 7 to OAC
- For a complete description of the Geography curriculum courses please see appendix A

With the lack of training offered at Faculties of Education, many teachers are left to learn GIS when they become employed with a school. Unfortunately, this will impede the adoption of GIS because of the limited amount of time practicing teachers have to acquire GIS skills. Even though GIS is a mandatory part of the grade nine curriculum, the Ontario Ministry of Education has provided few resources to train teachers on how to use GIS. The one resource the Ministry has supplied is an online course developed by ESRI Canada, unfortunately, from this author's experience, many teachers find the lessons on the site time consuming and challenging, especially for teachers who have limited computer expertise.

ESRI Canada also offers schools workshops conducted by their personnel, however at \$100 per day per person, these workshops can be expensive. Some teachers have taken courses in GIS during the summer months, but many of these courses are expensive and the ministry or the school board does not reimburse the teacher. Most often these courses are more suited for becoming GIS professionals rather than for secondary school teachers of GIS.

Ryerson Polytechnical University in Toronto is one institution that has filled the void left by the Faculties of Education for teaching GIS to geography teachers. Ryerson offers two separate courses for teachers: a *Certificate in Geotechnology for Teachers* or a *Course series in Geotechnology for Teachers*

(<http://www.geotechnology.ryerson.ca/>). The Course series in Geotechnology for Teachers offers several three day intensive programs like: Learning the basics of a Geographic Information Systems, Issues in Implementing Geotechnologies in High Schools and Using Geotechnologies in High School Environment Field Studies. These courses are attempting to become approved by the Ontario College of Teachers as Professional Learning Programs (PLP), which are courses that Ontario in-service teachers must take to maintain their teacher's licence. These courses are also wisely run during non-school hours, as many schools in Ontario have seen severe cutbacks in supply teacher funds making it difficult to take time off school to attend a course.

While these courses fill a void for the lack of teacher education in GIS, their major disadvantage is that Ryerson is located in Southern Ontario, making it less accessible to teachers who live in other areas of the province. To alleviate some of these issues, Ryerson Polytechnical also offers some of the courses through distance education, but requires that teachers have access to a computer with either Windows 2000 or Windows XP and high-speed Internet service (http://www.geotechnology.ryerson.ca/ver_lab.htm). Reiterating the issue with the lack of adequate computers in schools, many teachers will not have access to these more advanced operating systems unless they have them at home. While GIS training for teachers is available, it still is not universally available to all teachers across the province.

A final hindrance to these courses is that the Ontario Secondary School Teachers Federation (OSSTF), which is the union for all teachers of grades nine to OAC, has advised its members not to take the PLP courses as part of its on-going protest with the Ontario Ministry of Education. Due to the strength of the union in some areas, or because of teacher dissatisfaction with the government, many may not want to take Ryerson's courses.

McMaster University is also contemplating offering a teacher certificate in GIS (<http://www.science.mcmaster.ca/gislab/outreach/outreach.pdf>), however the most logical place to have GIS training is during a pre-service teacher's training at a Faculty of Education when both time and resources are available. Bednarz and Audet concur with this belief by stating:

...Because few new K-12 teachers receive training in GIS in their teacher preparation programs, inservice professional development will for some time remain the principal means for introducing GIS into geography instruction. As noted previously this will impede the adoption and diffusion of GIS into geography education because of the limited amount of time practicing teachers have to acquire GIS skills if training opportunities even exist (Bednarz & Audet 1998, p. 65).

An in-school online GIS course can help solve the problem of the lack of teachers available within one school with a knowledge of GIS, by offering one teacher who is trained in GIS to a variety of schools.

DUALITY OF GIS EDUCATION

Given the issue of the paucity of teacher training in GIS, how is GIS education currently implemented in secondary schools? Crechiolo (1998) found in her research that it is common practice in secondary schools in Ontario to emphasize the technology rather than to provide students with a background in geographical principles. For example, instead of teaching about scale, educators “are more likely to indicate the ‘dropdown menu’ from which the ‘zoom’ function may be activated” (Turner, 2000 p. 57). Turner (2000) argues that this practice is a result of the educators’ own lack of knowledge about fundamental geographic principles, which is only exacerbated by the use of ‘ready made’ lessons designed by GIS companies or organizations (i.e. ESRI). The author can concur with Turner’s view that many teachers rely heavily on the lessons designed by ESRI. While employed with the Ottawa-Carleton District School Board, the author witnessed many teachers handing out pre-packaged lessons without attempting to indicate to the students what they would be learning about that day.

The debate about whether secondary teachers should use GIS to teach about Geography or whether they should train students to become GIS users permeates the literature on GIS education. However, the literature strongly suggests that secondary educators use GIS to teach about geographical principles (Crechiolo, 1998; Heywood, Kemp & Reeve, 1999; Storie, 2000; Turner, 2000) for several reasons:

- GIS technology is rapidly changing, leaving teachers with little time to continually upgrade their knowledge base

- If students are taught on a product specific GIS (i.e. like ArcView in the case of Ontario), the knowledge gained on that system may not be easily transferable to another system
- Learning the technology rather than geographic principles means that students' skills will quickly become outdated, given the rapid changes in technology
- GIS software is expensive making it challenging for public education to provide schools with the newest software and data
- Students need to obtain a solid knowledge base in geographical principles

The “education versus training” debate is strongly centred on this last point. Storie (2000) argues that without having a solid knowledge base in geographical principles students will not be able to understand the “wider implications of what they are doing” with the GIS program (Storie, 2000 p. 12). This argument is sound as once students have a solid comprehension of geographic concepts, it is straightforward process to learn how to use specific GIS programs.

An online GIS course can help solve the problem of inadequate lesson content by providing reviewed, competent lessons developed by a teacher trained not only in GIS, but also in geographical principles. This online course has the ability to reach students across the province of Ontario and therefore fill the gap resulting from the lack of GIS training for secondary school teachers.

CONCLUSION

GIS in the K-12 curriculum has the ability to prepare students for future career opportunities, to provide students with the means to become independent

learners, and to enhance geographic education through achieving a greater understanding of the five themes of geography and developing advanced spatial skills. However, its inclusion by geography teachers is limited because of the lack of training and inadequate hardware. Training for pre-service teachers is virtually non-existent at the Faculties of Education in Ontario, and research (Bednarz & Audet, 1998) indicates this situation also exists in the United States. Most Geography teachers are then forced to learn GIS once they are employed as teachers, when time and learning opportunities are limited. Training opportunities at the Faculties of Education do have the potential to increase because of the rich knowledge of GIS in other areas of the university, like the Department of Geography. Upgrades in computer hardware, on the other hand, may be more difficult because of the current environment of stringent educational cutbacks.

When GIS is implemented in the secondary curriculum, it is often taught as a training course in a particular software program, such as ESRI's ArcView. In Ontario, teachers find this a simple solution to implementing GIS because of the availability of lessons that have been produced by ESRI for the secondary curriculum. However, without an understanding of the geographical concepts of the program, students may find their knowledge in GIS has become obsolete once the GIS program they were trained on is no longer in use.

An online in-school course produced by a teacher trained in GIS and in the geographical principles behind it, has the potential of delivering solid GIS education to secondary students. This form of educational delivery may be necessary in light of the inadequate hardware available to the majority of geography teachers in Secondary schools and the lack of GIS training available to geography teachers.

CHAPTER TWO

A HISTORY OF ONLINE LEARNING AND ONLINE GIS COURSES

INTRODUCTION

Online learning and more specifically, online GIS courses have increased dramatically over the last few years. A cursory search on the Web produces many hits on online GIS courses, especially at the post-secondary level. Institutions that offer online GIS courses include: Purdue University, Indiana (<http://pasture.ecn.purdue.edu/~caagis/tgis/getstart.html>); South West Texas State University (<http://www.geo.swt.edu/programs/onlineGIS/>); Curtin University of Technology, Perth, Australia (<http://www.cage.curtin.edu.au/gis/distance.htm>) and Birkbeck College, University of London (<http://www.bbk.ac.uk/gisconline/>). This is just a sampling of the many online GIS programs that are available.

To understand how online GIS course have become so common, it is important to consider the history of online learning and how it developed in both secondary and post-secondary education. It will be demonstrated that many of the various forms of educational delivery and theory began first at post-secondary institutions and then spread to secondary institutions. By understanding this history,

educators will be better prepared to develop GIS courses for the online secondary school student.

HISTORY OF ONLINE LEARNING

While Web-based distance education (a.k.a online learning) is a relatively new phenomenon, distance education (i.e. print based education, radio education and television education) has existed for well over a century. Distance learning is a broad term that is defined as learning through various media (i.e. print, computer) where the student and teacher are geographically separated (Hurley, Procter & Ford 1999). While most scholars distinguish online learning from the more traditional forms of distance education online learning evolved from distance education (Ahern & Repman, 1994 as quoted in Litke, 1998). Therefore, to understand how online learning evolved it is important to examine the development of distance education over the years. To achieve this, distance education will be examined in three separate sections that will correspond to Nipper's (1998) three generations of distance learning. Looking at these generations, which correspond to historical changes in communication and in technology, it will be shown that distance learning has improved over the years to not only create a greater sense of community (Sumner, 2000) but also an enhanced source of educational delivery.

The first generation: correspondence study

Correspondence study involves the use of print based course materials and the postal service for communication between teachers and students. This form of study still exists today, but first appeared in the mid 1800s due to the development of the printing press, low cost pens and the demands of the Industrial Revolution for an educated workforce (Sumner, 2000). The first largely recognized correspondence course was offered in England in 1840. This was a course in shorthand meant to educate business administrators (Verduin & Clarke, 1991 as quoted in Sumner, 2000).

Correspondence courses quickly caught on so by the end of the nineteenth century they were flourishing among European, American and Canadian Universities (Sumner, 2000). In Canada, Queen's University in 1889 was one of the first post-secondary institutions to offer correspondence courses (Rogers, 1993). Many of the reasons for taking correspondence courses during this time are the same as those for taking online courses today; one of the major ones being distance from educational institutions, which was a key concern in this more rural age. By the 1920s most provinces in Canada offered some form of correspondence course for elementary and secondary school students (McKinnon, 1995). The majority of the students enrolled in these courses were unable to attend school because of "illness, distance from school, extended

family travel or diplomatic and missionary posting of families to other countries” (McKinnon, p. 63, 1995).

While correspondence courses offer a means to achieve an education, they have two major disadvantages, one of which is the lack of interactive two-way communication. The result of this is “a very individualized mode of learning that tends to isolate and insulate students from the group learning process (Sumner, 2000, P. 275). It also tends to “...preclude the creation of public space and interactivity” (Sumner, 2000, p. 273). The other major disadvantage is with the only form of educational delivery being through print, it does not appeal to all the intelligences in Howard Gardner’s multiple intelligence theory.

The second generation: multimedia distance education

With the wide use of the radio in 1930s and later the television in 1950s, distance education courses in the second generation could offer a new means of educational delivery that expanded upon the print based method. These courses also helped decreased the isolation felt by the learner, as well as provided new forms of media (sight and sound) that offered different ways of learning.

In Canada, one of the first experiments with radio distance education began in 1925 with the University of Alberta, which aired courses over a private radio station (Rogers, 1993). Other universities also adopted the idea of using the radio as a form of educational delivery, for example St. Francis Xavier had

continued success with the radio in the 1930s and 1940s for its adult education program (Rogers, 1993).

Public schools in Canada followed the examples of post-secondary intuitions with one of the first radio distance education courses broadcasting in the late 1930s in British Columbia (Fleming and Toutant, 1995). However, for public schools the country that epitomizes this generation is Australia with its radio classes for elementary and secondary students living in the Outback. One of the first schools to provide education over the radio for these isolated children was Broken Hill School of Air. Beginning in 1956, students learned through print material, supplemented with audiotapes and two 'live' 30-minute lessons per week delivered via the VHF (high frequency) radio network (<http://www.db.csu.edu.au/division/marketing/tms/T101/T101p5.htm>). This school still exists today but employs the Internet and satellite technology to deliver education to school age children (<http://www.db.csu.edu.au/division/marketing/tms/T101/T101p5.htm>).

With the wide use of the television, the British Open University became the hallmark of this generation (Litke, 1998; Manson, 2000; Miller, 2000; Sumner, 2000), offering a variety of courses through this medium. Beginning in 1969, these courses quickly gained in popularity in the United Kingdom because they were "well produced, carefully designed, and taught by professional academics in their respective fields" (Miller, 2000 p. 8). Produced at a cost of almost US\$1 million for each course, the British Open University was able to offer the very

best in distance education, even bringing the camera out into the field (Miller, 2000). The United States (U.S.) also offered a similar program called Sunrise Semester in the 1960s. However, since it was difficult to differentiate a TV class from any class held in a lecture hall, Sunrise Semester never gained the popularity of the British Open University (Miller, 2000). This is an essential point to remember when developing an online course; if the online course does not utilize the technology available, it will be difficult to distinguish from a traditional classroom course and may not enrol the number of students needed to make it viable.

This generation of online learning was an improvement on the first generation since two-way communication was possible between teacher and student through either the telephone or ham radio. However, this form of communication was often inadequate because of cost, clarity and scheduling (Sumner, 2000). It also provided limited forms of multimedia delivery and did not provide an area of public space (Sumner, 2000).

The third generation: computer mediated distance education

Educators quickly utilized the Internet, developed in the early 1970s for the U.S. Department of Defence, as a new resource for educational delivery. One of the first totally online courses was an Executive Education program launched in 1982 by the Western Behavioral Sciences Institute (WBST) (Harasim, 2000). This

course involved long text based lectures, which the faculty, who were new at this form of delivery, quickly learned did not work (Harasim, 2000).

By 1992 the Internet had evolved into the World Wide Web (Web). The Web is a system of Internet servers that supports Hypertext Mark-up Language (HTML), which in turn supports links to other documents as well as graphics, video and audio (http://www.webopedia.com/TERM/W/World_Wide_Web.html). This multi-sensory format meant that more dynamic online courses could be offered than those available before the Web, creating an increase in the number of courses available. Wide use of electronic mail (e-mail) also increased the number of courses since it offered a means for instructors and students to communicate asynchronously. The increase in online courses was also driven by the Information Economy's need to quickly train the workforce in the ever changing new technologies.

Beginning in the mid 1980s The British Open University (OU), using its experiences with the television began offering courses via the Internet (Mason, 2000). In the 1990s, OU was able to make their courses more interactive through the purchase of FirstClass, a software program used to build online communities. Students and teachers were now able to communicate through email or online chats with a "robust and well supported software" program (Mason, 2000). This greatly improved two-way communication and many distance education students found their instructors to be more reachable through

the use of email. Students also found that they were able to communicate with each other providing a greater sense of community. Online discussion boards used at OU and at other institutions offering online courses also increased the use of communication between students and decreased the sense of isolation. In 2000, about half of the 250 000 students enrolled at the British Open University took their whole course on the Web, the rest using CD-ROMS or a combination of the Web and CD-ROM (Mason, 2000).

Following the example of universities, British Columbia began to experiment with online learning in public schools. In the 1993-1994 school year the British Columbia Ministry of Education and the Open Learning Agency began a pilot project where senior secondary correspondence courses were adapted to contain media other than print-based media (McKinnon, 1995). These courses experimented with various combinations of television broadcasts, videotapes and most importantly, online learning. While courses were not entirely online, the program did provide some of the first experiments with online learning in the secondary school system, which helped in the creation of subsequent online courses.

A cursory search on the Web will easily show how online learning has infiltrated secondary school education. For example, the Ottawa-Carleton District School Board (OCDSB) has been experimenting with this form of delivery for the last 2 years by offering several online courses through Blackboard. Blackboard is an

Internet infrastructure software designed specifically for online learning. It was chosen by the OCDSB because of its reliability, security and its ability to allow for creativity for the online teacher (Levesque, 2002). Other fully online schools exist in Canada, including: Fraser Valley Distance Education School in British Columbia (<http://www.fvrce.gov.bc.ca/>), VirtualHighSchool.com, which claims to be the oldest online program in Ontario (<http://www.virtualhighschool.com/>) and Northstar Academy, which is an online Christian school in Alberta (<http://www.koinoniaschools.com/KCESnorthstar.htm>). It is evident that the types of online learning for secondary school students is diversifying as this form of educational delivery becomes more popular.

Online courses have improved on the first two generations of distance education by providing the opportunity for students and instructors, as well as students among themselves, to participate in two-way communication. Linked by online chats and discussion boards, students feel less of a sense of isolation and more of a community, thus a public place is created with online learning (Sumner, 2000). The multi-sensory delivery of online education also creates an environment that is well suited to the different intelligences as described by Howard Gardner.

HISTORY OF ONLINE GIS COURSES IN POST SECONDARY EDUCATION

To achieve an understanding of how an online GIS course can be implemented in secondary school education, it is important to examine the history behind

online GIS courses, and their development in post-secondary institutions. The increase in online learning was partially promoted by researchers questioning the traditional university's ability to deliver an adequate education to all students. For example Forer (1997) argues, "GIS education is embedded in a geography of tertiary learning which since the mid-20th century has been dictated by an increasingly Fordian view of mass undergraduate education" (Forer, 1997, p.170). Forer compares the traditional university method of education to the assembly line at a Ford car plant as university education is dictated by a "rigid timetable of lectures" and is delivered through an inflexible system.

This traditional campus based model is being challenged by changes in information technology, such as the Web, and in the life circumstances of students. With increasing tuitions and decreasing loans many students are forced to supplement their income with part-time jobs, which restrict the amount of time they can spend on campus (Forer, 1997; Diabase, 2000). There is also a growing number of older students returning to universities to seek a degree or to take courses. In the United States the numbers of traditional college and university students (ages 18 to 24) have only kept pace with the overall growth of the US population (Diabase, 2000). However, the number of students 25 years and older is increasing and represents a major area of growth for universities and colleges. These students most often have careers, families and other life circumstances that affect the amount of time they can spend on campus.

While the decreasing enrolment of the traditional university student does not exist in Canada, mature students do represent a significant portion of the university population and many universities are addressing their needs. However, in Canada, it is the dramatic increased enrolment of the traditional university student which is expected to greatly affect the way post-secondary institutions operate. According to the Council of Ontario Universities (2001) the percentage of students who are of traditional university age (18-24) is expected to increase by 22% from 1999 to 2014 (Council of Ontario Universities, 2001, p.2). This increase, coupled with the double cohort (two graduating classes, one under the new grade 12 system and one under the old OAC system) in 2003 in Ontario has put a great deal of strain on the amount of space at universities. Universities, especially for those universities in large city centres, are also struggling to find the space not only to accommodate these new students, but to also accommodate the many new professors who have been hired to teach them. These pressures are forcing many institutions in both Canada and the United States to look at other alternatives to the traditional campus based university model.

With the advent of the Web, many universities are turning to the Internet as an alternative means to deliver education. GIS instructors are particularly interested because of their familiarity and interest with computers (Solem, 1999). A recent study by Solem (1999), found that not only were GIS professors more likely to be involved in online learning than their human geography counterparts, they were

also more likely to believe "...that the Internet improves the effectiveness of geographic instruction" (Solem, 1999 p. 226).

CASE STUDIES OF ONLINE GIS COURSES

Some of the first experiments with GIS multimedia occurred in the late 1980s; these include ARCDemo (1997) and GISTutor (1989) (Zerger et al, 2002). Both of these programs were created using a hypermedia program and were not delivered through the Internet. For example, GISTutor was created using Apple Macintosh's Hypercard, which used an Object Oriented Language to include graphical and textual materials. GISTutor was hailed for its enhanced graphics, its ease of use and its excellent presentation of an overview of GIS functions (Raper & Green, 1992).

The lessons learned in creating tutorial programs, like GISTutor, helped professors design online GIS courses in the 1990s. One of these early projects is the Geographer's Craft. This project, which began at the University of Texas in 1991, was developed "to test a new idea for organizing introductory training in GIS...and to prototype hypermedia instructional materials in the Worldwide Web" (Dana, 1995; Foot 1994 as quoted in the Foote, 1997). The Geographer's Craft is composed of online material, lectures, discussions and labs. All written material and lecture notes are posted on the web and students are also provided with space to create their own website. This space provides students with the opportunity to experiment with Web design and to publish the results of two

projects. Students are asked to hand in all assignments via email and are encouraged to communicate with the professor through this medium.

The University of Melbourne also runs a similar program where Macromedia Director, Flash and Shockwave have been used to create multimedia-learning modules to teach GIS to undergraduate and graduate students (Zerger et al., 2002). Like the Geographer's Craft, formalized lectures are still used, as the aim of the University of Melbourne is "...to enhance rather than replace traditional GIS learning models such as lectures, tutorials and practical assignments" (Zerger et al, 2002, p. 68).

University Geographic Information Systems (UNIGIS) follows a different model for online learning than the University of Melbourne. Here, the aim is to replace traditional teaching with interactive multimedia online learning, thus, the entire course notes, computer exercises, discussions and reading materials are delivered via the Web. The programme was created in 1990, making it one of the oldest Web-based distance learning initiatives (Molendijk and Beinat, 2001). With 15 institutions and over one thousand students it is also one the largest online GIS programs (Molendijk and Beinat, 2001).

ONLINE GIS LEARNING IN SECONDARY SCHOOLS

It is not known how many online GIS courses exist in secondary schools across North America, but a search of the literature and also online has produced some

results. Some universities and colleges in the United States have encouraged secondary school students to enrol in their online GIS courses (Charlotte Lauerman, email to Author). Examples of this exist at the University of Montana where secondary students are encouraged to enrol in GIS courses meant to instruct K-12 teachers in GIS (Lauerman, 2002). Students enrolled in this online course use school computers equipped with ArcView 3.x and GIS data. Students access the computers during regular school hours. This type of online course is the format that is promoted in this paper.

The other known source of online GIS courses for secondary school students comes from ESRI's Virtual Campus. ESRI's Virtual Campus is a series of online learning models that teach how to use GIS. In the United States, ESRI site licenses for school boards include the Virtual Campus, and as a result schools use this to teach students about GIS in a learning module format with the classroom teacher present (Fitzpatrick, 2002). One school that has used this method effectively is Oakmount Regional High School in Ashburnham, Massachusetts. Using GIS in its environmental program, students began to learn GIS by working through two Virtual Campus courses. The students then used their newly acquired skills to explore environmental issues ([http://campus.esri.com/campus/catalog/casestudies/CaseStudy.cfm?o=oakmont &CFID =3920870&CFTOKEN=34039824](http://campus.esri.com/campus/catalog/casestudies/CaseStudy.cfm?o=oakmont&CFID=3920870&CFTOKEN=34039824)).

Using ESRI's Virtual Campus courses in Secondary Schools does provide students the opportunity to learn GIS, however there are several concerns with incorporating it into the secondary curriculum. The major issue is that the Virtual Campus courses were not created or designed with the adolescent in mind. They were created for the adult learner and are thus structured differently than they would be if they were designed specifically for the secondary school student. Another issue is that while these courses do have exams, they are not designed for evaluating the secondary school student. Use of the Virtual Campus courses also assumes that the school has an adequate lab to provide for GIS instruction by the geography teacher; it has been argued in this paper that geography teachers rarely have access to these types of labs. Finally, the Virtual Campus courses are not part of the package licensed by the Ontario Ministry of Education, and therefore cannot not be used by schools in Ontario, unless they are willing to purchase them on their own (Kelly, 2002).

CONCLUSION

Examining the literature on the history of online learning in both secondary and post-secondary institutions, demonstrates that secondary education is ready to use this new form of educational delivery. History shows that many forms of distance learning began first at post-secondary education, and then slowly moved into the secondary realm. This is certainly the case with online GIS courses, which are common at the post-secondary level, and are starting to move into the secondary school level. Secondary education is only beginning to

use GIS as part of its course material, but as demonstrated in Chapter One GIS is quickly becoming part of the curriculum for many provinces in Canada. Once GIS has been integrated into the curriculum, online GIS courses can grow. Ontario is ready for experimentation with this form of delivery for GIS as it is already part of the curriculum.

CHAPTER THREE

THE TRADITIONAL CLASSROOM VERSUS THE ONLINE CLASSROOM

INTRODUCTION

The instructional potential of the Internet is extraordinary. Yet, despite the number of online high school courses available, most school boards have only begun to scratch the surface.

Proponents of online learning stress that with today's digital economy; students need experience in communicating with and using online environments. For example, Donna Miller, coordinator of the West Virginia Virtual School (WVVS), points out that "the world is working in an online environment and students should be prepared" (Rourke, 2001, p. 10).

Other proponents stress the need for continual education demanded by the information-based economy. Thus, online learning will become important so that workers will not have to take leave from work to learn new skills (Holt, 1996 as quoted in Taylor, 2000). Students who have experience in using online learning are likely to be quick learners in the workforce.

This new approach also offers administrators a way to address problems such as chronic teacher shortages. According to the Canadian Teacher Federation the number of people applying to teacher education programs in Ontario dropped 26% from 2000 to 2001, despite excellent employment opportunities (<http://www.ctf-fce.ca/E/WHAT/OTHER/COLLEGE.html>). The federation also states that of the 140 000 teachers currently employed in Ontario, 56 000 are expected to retire by 2010. These statistics will obviously have some sort of impact on the number of GIS trained teachers available within the secondary school system.

Most importantly, online learning offers high school students a new and innovative way to learn. This chapter will examine online learning by taking a critical look at its advantages and disadvantages. It will also examine which types of students are most successful in this form of learning.

BENEFITS OF ONLINE LEARNING

While online learning is still in its infancy in secondary education, there is a great deal of information in the literature extolling its benefits (such researchers include Hopey & Ginsburg, 1996; Litke, 1998; Hurley, Proctor & Ford, 1999; Barker, 2000; Hardwick, 2000 and Chaney, 2001). This section will carefully examine these benefits.

Constructivism and Multiple Intelligences

Perhaps the most widely discussed effect of online learning is that it is seen as providing a different form of teaching and learning from the traditional classroom. A growing body of literature supports the view that online learning offers a paradigm of education that is centred around learners rather than around teachers with structured lesson plans (Forer, 1997; Hopey & Ginsburg, 1996; 1997; Litke, 1998; Freundschuch and Helleviks, 1999; Barker, 2000; Haraism, 2000; Rourke, 2000; Taylor, 2000; and Thirunarayanan & Perez-Prado, 2002). Hopey and Ginsburg (1996) argue that in online learning courses, instructors are transmitters of knowledge and not facilitators of knowledge; and they suggest that this benefits students as they can take greater control of their own learning. This is attractive to many parents and students who are dissatisfied with current classroom teaching methods (Arai, 2000).

Educational theorists view online learning as fitting the mould of the constructivist paradigm of learning, which is the dominant educational school of thought (Hung, 2001). The constructivist paradigm, developed by psychologist Jean Piaget, stresses the notion that students learn best through knowledge discovery. According to Litke (1998, p. 72) in her PhD thesis, the constructivist paradigm argues "because all individuals are influenced by their own cultures, it is not possible to describe external reality in a general way". Thus, when students are provided the means to control their learning, either through problem solving or other means of self-discovery, they are able to attain knowledge by placing it in a

context that fits with their culture and own unique experiences. Litke (1998) as well as Hurley, Proctor & Ford (1999), Hung (2000) and Zerger et. al. (2002) argue that because the nature of online courses is student centred, students have greater control of their learning and thus retain knowledge more efficiently.

The literature also comments on how the multimedia environment of online learning is attractive to the various intelligences in Gardner's multiple intelligence theory (Freunschuch & Hellvik, 1999; Passey, 2000; Shea-Schultz & Fogarty, 2002 and Vrasidas, 2002). Shea-Schlutz and Fogarty (2002, p.21) write "while e-learning technology cannot determine the right method to present a particular course to an individual (yet), it does increase the odds of success by providing multiple paths for learning". This point is clearly illustrated by examining the table (table 3.1) developed by Freunds Schuh & Hellvik (1999) linking the various intelligences to the media found in a Web based course.

Freunds Schuh & Hellevik contend that "... by providing a variety of mediums by which we can convey information, learners who posses different strengths and abilities in each of the different intelligences have multiple mechanisms that will encourage them to learn to their fullest potential" (Freunds Schuh & Hellevik, 1999, p. 276). By providing different ways to engage students, educators create environments that can suit the needs of many different students with many different learning abilities and learning styles. It should be noted, however, that these assumptions of multimedia learning and its appeal to multiple intelligences

is something that is proposed in the literature and has little empirical evidence to back it up.

Table 3.1 Media and Potential Multiple Intelligences

Medium	Multiple Intelligence
Sounds (music and narrative)	Musical Logical-mathematical Linguistic
Video (including sound, images and movement)	Musical Logical-mathematical Linguistic Spatial Kinaesthetic
Text	Linguistic Musical
Animation	Kinaesthetic Spatial Musical Logical-mathematical Linguistic
Interactivity	Kinaesthetic Spatial
Hypermedia	Spatial Kinaesthetic Logical-mathematical

24/7 Learning

The opportunities for online learning to place education in the hands of students are numerous. One of the best examples results from the nature of the Web, which allows students access to their course material 24 hours a day, 7 days a week (Barker, 2000). This allows students the ability to review lectures as often as they wish, something they would be unable to do in a traditional classroom. With many courses structured so that assignments have no assigned due date (but, all assignments to be completed by the end of the course), students have

the advantage over their classroom counterparts as they can work at their own pace. Thus, more advanced students can work at a faster rate, while those who need more time can use it to complete more refined assignments. This overcomes the situation in a regular classroom where the teacher is forced to teach to the middle student, leaving those who find the material too easy and those who find it too challenging to fend for themselves.

In the case of an online in-school course, students will not have access to the course material twenty-four hours a day, seven days a week since they will be restricted to taking the course when they have their assigned time in the computer lab or the library. However, the in-school online student still has the advantage over the traditional classroom student by being able to move through material at his or her own pace.

Access to Information

The nature of the Internet also provides students with the opportunity to examine information that was previously stored in libraries or in databases. Taylor (2000, p. 13) argues this is beneficial to students as “the Internet’s ability to foster time-space convergence allows current material from diverse places to be incorporated into a course”. Thus, students have access to information through scholarly journals, government sites, organizations, and online newspapers that will not be published in high school textbooks until much later.

Interaction

Another advantage that online learning students have over their classroom counterparts is that they benefit from more frequent one to one contact with their teachers than traditional classroom students do (Dede, 1996; Reeve et al, 2000 and Thiruarayanan & Perez-Prado, 2002). Use of electronic mail (email) allows students the convenience of contacting their teachers at any time of the day or week. Dede (1996) has also argued that many students lose their shyness when communicating through delayed (asynchronous) email. This is beneficial for those students that may be too shy to approach a teacher about a problem. The safety of asynchronous email allows a certain amount of anonymity, as there is no face-to-face contact. These shy students are also more likely to contribute to online discussions than in traditional classroom discussions (Taylor, 2000). Instantaneous (synchronous) email exchanges, like those found in online chats, are also beneficial to students as they provide a sense of community and remove feelings of isolation. It also helps students who wish to receive instantaneous help from instructors on assignments.

Online learning also provides the ability to engage in collaborative learning between students who are geographically separated from each other. Throughout the literature, collaborative learning is generally thought to be beneficial to students as it provides them the opportunity to learn teamwork skills with people from diverse places (Lemke & Ritter, 2000; Hardwick, 2000). Hardwick (2000) argues that collaborative learning provides an excellent means

to acquire new knowledge since it utilizes a student's encounter with the world.

She states

This view does not discount the importance of learning facts, but it emphasises the value of knowledge as actively constructed through inquiry. Specific content is thus often less important than the ability to pose significant questions to learners and let them pursue the answers to these questions. This approach to good teaching emphasises the mastery of deeper levels of knowledge rather than simply transmitting data and information (Hardwick, 2000 p. 127)

This, of course fits in with the constructivist paradigm of learning. Researchers like Hardwick (2000) and Lemke & Ritter (2000) state that online learning is a perfect vehicle for fostering collaborative learning tasks and activities. Using email, video conferencing, or online bulletin boards students can work on projects with students from around the world. Such learning is excellent for students wishing to use a networked GIS.

Equal Learning Opportunities

Chaney (2001) argues that online learning offers equal learning opportunities regardless of the economic situation of the school board. Chaney illustrates this concept by using the comments of Tom Layton, a technology teacher at a cyber school in Oregon:

Distance education finally brings democracy to education. It gives the student in East L.A. or Brentwood, or Martha's Vineyard, or Harlem...an equal opportunity to content curriculum and to people with many perspectives. I believe students who learn with each other will learn from each other. Until now, the single biggest factor influencing the quality of education was where you live. If you don't believe me, ask any real estate agent (Chaika, 1999 as quoted in Chaney, 2001 p. 22).

Students in online learning classes will not be disadvantaged if they live in poor socio-economic boards as they will have access to the same teachers and content as those students who live in rich socio-economic boards. Students will also have the same access to advanced or specialized courses that may not be offered in traditional classrooms because enrolment is too low to economically justify the course.

Online learning has many advantages over the traditional classroom, including: continual updated materials, opportunities to take responsibility for own learning, ability to learn at own pace and greater interaction with instructors and fellow students.

DISADVANTAGES OF ONLINE LEARNING

While the majority of the literature expresses positive views towards online learning, there are some critics who argue that it is just another of a long line of the latest and greatest in educational delivery. While few proponents of online learning would suggest it can cure all that ails North American education, it is important to examine the weaknesses of this new media to understand the areas where it may fail.

Learning the technology with the content

An important critique is one put forth by Schrum and Hung (2000), who argue that learners face incredible challenges in adapting to online environments. They

state that a great deal of time in an online course is spent in learning how to use the various tools available to them and that these tools must be mastered effectively before they can begin to be used to construct new knowledge. They also argue that students must feel comfortable using file management and checking email to succeed in an online course. However, it can be argued that these types of skills are necessary in today's digital age, so learning them in an online course in high school is an excellent opportunity. Regardless, it is important for online course teachers and designers to note that students face considerable challenges if they have to learn the technology at the same time they are learning the content of the course. It is therefore important for teachers and designers to create a learning environment that is intuitive.

Unequal Learning Opportunities

While students in an online course do have equal access to the same materials, regardless of what school district they come from, there are issues of inequality. If a school has access to the Internet, the speed of the connection may differ from student to school. While it would be nice if all schools had access to high speed Internet connection, which makes downloading and video streaming infinitely easier, many schools will be using a 56K modem.

The level of computer hardware may also differ from school to school, which depending on the requirements of the course may put some students at a disadvantage. Hara and Kling (2000) found in their study that students

experienced “frustration, anxiety and confusion in a small graduate course due to communication breakdown and technical difficulties” (Hara & Kling, 2000 as quoted in Schrum & Hung, 2002 p. 7). Bandwidth speed and hardware requirements are of course important considerations when developing an online GIS course. Therefore, online learning materials should be designed to the technological specifications of the least well-equipped school represented in the course (Reeve et al, 2000).

Is Student Centred Education Superior?

While proponents of online learning extol its benefits because it suits the paradigm of constructivism, Taylor (2000) suggests that we should examine the truism that student-centred education (i.e. constructivist paradigm) is superior to teacher-centred education. If students are empowered to explore their own interests, Taylor wonders what will stop students from “using the Web to play games (and) discuss Star Trek trivia...” (Taylor, 2000 p. 17). This is an important consideration when dealing with high school students who are less experienced with having control over their learning. However, most researchers, like Shea-Schultz & Fogarty (2002) would argue that today’s classroom learning is more suited for creating workers for the industrial revolution than for developing students for careers in the digital age.

Isolation

Taylor (2000) has also argued that many online students have feelings of isolation. The author during her time as an online student in a programming course felt this and experienced frustration in the course because of it. It is therefore important for teachers to maintain a constant connection with students and to provide opportunities to promote discussion between students. The author's feelings of isolation dissipated after meeting a fellow classmate online who wanted to use synchronous email to work on projects collaboratively.

Dangers of Email communication

Teachers have also noted that some students are inexperienced with non-verbal communication, and this has lead to miscommunication between students and between student and teacher. Litke (1998, p. 56) states "...the computer acts as a filter for many verbal and all nonverbal signals. This filtration factor prevents people from communicating facial expressions, body language and tone of voice that constitutes the inaudible but vital component of most face-to-face communication". Taylor (2000) has also noted that students are more likely to become sarcastic in email discussions, partial because of the feeling of anonymity brought on by this form of communication. To avoid this and other forms of miscommunication, Goett and Foote (2000) stress the importance of teaching students 'netiquette', so they are aware of the problems and pitfalls of email communication. Netiquette are the etiquette rules used when communicating online. Since email communication is used extensively in the

'real-world', understanding how to use email communication effectively is a beneficial skill for high school students to learn.

Online Learning and the Instructor

From the perspective of the instructor, many feel that teaching in an online course dramatically increases the amount of work they have to do. One of the most cited causes of the increased workload is the amount of email that they have to respond to. Annette Levesque, online teacher for the Ottawa-Carleton District School Board, explained in an interview with the author that explanations that would take a few seconds in person become a lengthy process over email (Levesque, 2002). However, Ritter and Lemke (2000, p. 101) note that even though teachers see students everyday in a traditional classroom it does not allow them to provide individualized attention to the students because of the "pace and amount of material covered and the size of ...classes". They also note that while teachers may hold regular office hours, busy and conflicting schedules prevent students from contacting them. Annette Levesque, while noting the amount of email, stated that she knew more about her online students than she did about her traditional classroom students because of this method of communication.

Teachers have also stressed the amount of time it takes to construct an effective online course. Hurley, Procotter & Ford (1999) discovered that they did not

accurately predict the time it would take to create an online undergraduate geography course. They state that

Creation and maintenance of the course Web page was time consuming (approximately 30-40 hours) to design update and troubleshoot. The time spent troubleshooting technical issues such as posting files to the Web was considerable (approximately 2-3 hours per week) (Hurley, Proctor & Ford, 1999, p. 133).

Solmen (2000, p. 35) argues that “teaching with the Internet requires a repertoire of skills in computer application and instructional techniques, that has until recently been practised by few educators”. He makes an important point that creating interactive and educational online learning courses requires far more skills than most educators have. For those teachers who are effective and experienced teachers, but are new to Web page design, creating an online course can be very challenging. In these situations, it is often better for teachers to use outside help in producing the Website.

Another disadvantage with online learning is the amount of marking that is involved compared to a traditional classroom. Annette Levesque, in an interview with the author, described the overwhelming amount of marking in an online course as compared to the traditional classroom environment. She stated that with students finishing assignments at different times and with the need to provide constant feedback, there is never a break in the marking. The amount of marking is unavoidable as online teachers need to provide feedback so that students know there is a teacher guiding them and monitoring their progress.

Regulation of the Web

A final disadvantage with online learning is that the Web is totally unregulated. Taylor (2000, p. 17) argues, "it is distinctly possible that students might search for websites on the Holocaust, find sites of Holocaust revisionists and conclude that the Holocaust did not actually happen". However, it is important for high school students to learn how to evaluate resources effectively and working in this environment is a perfect opportunity to do so. To guide students in this, teachers should add a component about how to evaluate websites in every online course.

COST

The topic of cost of online learning courses is placed as its own subheading as there is disagreement in the literature about whether or not online learning is less expensive than traditional classroom learning. Most researchers agree that creating an online course is far more costly than developing a traditional classroom course (Bartolic-Zlomislic & Bates, 1999; Taylor, 2000; Thomas, 2000). Reasons for additional costs are due to the expensive technology needed, the cost of hiring specialists to create and maintain courses, and the costs to train teachers to work in this environment.

The cost to develop an online course varies widely in the literature from a few thousand dollars to hundreds of thousands of dollars (Thomas, 2000). As this technology is relatively new, it is difficult for institutions to accurately predict the costs of developing and maintaining online courses. A recent study by Bartolic-

Zlomislic and Bates (1999) examined the costs incurred by three Canadian universities in developing online courses. Looking at the University of British Columbia, the researchers found that the start-up costs were substantially higher than originally anticipated; in fact they were 75% over budget.

Proponents for online learning argue that these courses offer economies of scale, thus after an investment of time and money, the cost of usage per incremental student will be low (Massey & Zemsky, 1995 as quoted in Taylor, 2000). Bartolic-Zlomislic and Bates (1999) found economies of scale existed for the online course at the University of British Columbia as costs decreased substantially for the second and subsequent offerings. Proponents of online learning argue that online courses are more cost effective than traditional classroom courses as there is less cost in building maintenance, classroom space and labour (Forer, 1997; Jung & Rha, 2000; Shea-Schultz & Fogarty, 2002).

As it is unclear whether or not online courses are more cost effective than traditional classroom courses, their creation should only be justified if the course is needed. Since it has been argued that there are few teachers available who have the skills to teach a Geomatics course, creating an online course will be able to serve all students throughout the province of Ontario. Costs for the online GIS course should also dramatically decrease the cost of GIS education since a whole classroom of computers will not have to be reserved.

STUDIES OF STUDENT ACHIEVEMENT IN ONLINE LEARNING COURSES

Studies of the achievement of students who have participated in online learning programs have been extensive, however the majority of these have been inconclusive. This section will look at two studies that have examined student achievement in online learning courses, one in secondary education and the other in post-secondary education.

Urven et al (2000) conducted a study on high school and university student achievement in an online science course. Their study compared the learning achievements of students in a traditional course to students in a course that utilized both the Web and live video/audio transmission of lectures. After completion of the course, the researchers examined their results and found no significant difference in the final grade between this style of learning and traditional classroom learning. They also found no significant relationship with the final grade and the students previous experience with the Internet.

Neuhauser (2002) reported similar results in her study conducted on business students at Madonna University, Livonia, Michigan. She compared two sections of the same course taught by the same instructor; one course was online and the other was in traditional classroom to look. Like Urven et al (2000), Neuhauser found that the retention rate was identical for both groups.

While most studies do not find a difference in grade outcome between online learning and traditional classroom learning, many researchers, including the studies conducted by Urven and Neuhauser have found that students preferred online learning compared to traditional classroom learning. This theme is common throughout the literature and can be found in studies by Hurley, Proctor & Ford (1999) and Thirunarayanan & Perez-Prado (2002).

An online GIS course for high school students can be justified in the knowledge that studies have proven students perform equally well online as in the traditional classroom. The arguments for creating an online course are further enhanced by studies indicating that students show a preference to online learning.

WHO SUCCEEDS AT ONLINE LEARNING

Since research suggests that students perform equally well in both the traditional classroom and the online classroom, it is important to examine what type of student will succeed best in an online environment within school grounds. Barker (2000), suggests that the following students often feel more comfortable in an online environment:

- Gifted students who can progress faster in an online environment than in traditional classrooms
- Students who do not have access to the courses they wish to take
- Students who are attracted to the technology

Annette Levesque, online teacher for the Ottawa-Carleton District School Board adds to this list by suggesting many of the students who were successful in her class were those typically labelled 'youth-at-risk'. Youth at risk are generally those students who are not performing well in school, or are in danger of not performing well because of living situations or life circumstances or because of language and/or cultural barriers. Some of the students who performed well were those who had issues with the structured environment of a traditional classroom, or had issues handling authority figures. Teen mothers or those who had other challenging outside responsibilities succeeded well in her classrooms because of the flexibility that online learning offers. She also stated that students who were competitive athletes enjoyed this form of learning because of the flexibility it offered.

Roblyer (1999) argues that students also need to be self-motivated, have a good attitude towards the subject material and feel comfortable with the technology. Most importantly, he argues students should be participating in the online course out of their own choice rather than having a choice forced upon them.

With these characteristics in mind, online learning offers an alternative choice to many students who are looking for a different form of education than that found in the traditional classroom.

CONCLUSION

While few researchers would dare to predict the demise of the traditional classroom, researchers have suggested that educators and administrators would be wise to view online learning as an option for their schools (Rourke, 2001). With current issues such as smaller budgets and teacher shortages, online learning offers a viable alternative to classroom learning. Looking specifically at GIS education, there are very few teachers who have the skills necessary to effectively teach a course in this subject (see Chapter One). Thus, online learning can provide students with both effective content and an effective teacher no matter where the student resides. There is also a lack of computer hardware available to completely run a traditional GIS course; use of an in-school online course will allow students access to more adequate hardware.

Online learning is also an excellent option for students who are dissatisfied with today's form of teaching or who have difficulty adjusting to the traditional classroom because of life circumstances. While online learning will not replace traditional classroom learning, it does contain many advantages that make it an attractive complement.

CHAPTER FOUR

EFFECTIVE DESIGN OF THE ONLINE COURSE

INTRODUCTION

There are a large and growing number of online courses available, but some are more successful than others in providing an effective learning environment. Mitchell, Dieppta and Kerr (2001) have criticized some online courses for being unaltered versions of the traditional courses on which they are based. They argue that what makes an effective traditional course does not always make an effective online course if it is not restructured to take into account the new delivery system. The opposite can also be true; some courses do take into account the new delivery system and provide a well-organized and interactive environment. However, the content of the course may not be accurate or relevant, thus also leading to an unsuccessful course.

So what constitutes a good online course? This chapter will attempt to answer this question and how it relates to GIS education by examining: the process of designing a course, issues of content accuracy, Web design, motivation of students, teaching styles, and evaluation of courses. It will also look at three case studies of online learning and evaluate their effectiveness.

THE PROCESS OF DESIGNING A COURSE

The first step to designing an effective online course is to first consider the process involved. Weston et. al. (1999) have developed a comprehensive list of nine guidelines for online course developers. These guidelines are based on their own experiences in teaching in an online environment and researching the literature. They are as follows:

Impact on Learning

Weston et. al. (1999, p. 39) consider the first question to ask before designing a course is to determine if “the impact on student learning will be sufficient to justify the time, effort and resources necessary”. They find this an essential step because of the extraordinary amount of time required in creating, managing and teaching in this environment. The need for an online GIS course is evident because of the lack of current and incoming teachers who have adequate experience with GIS to teach a course (these issues were discussed more thoroughly in Chapter One).

Student Access

Weston et. al. consider the next step to designing a course is to establish student access to the online environment. From the author's experience in working for the Ottawa-Carleton District School board, most high schools have computers that are adequate for GIS in the library, which the students can easily use. Weston et al also strongly urge instructors to design courses that can be accessed by a variety of platforms (both Macintosh and Windows computers) and a variety of browser (Internet Explorer, Netscape Navigator, Mozilla etc.). Since the Ontario Ministry of Education has licensed ArcView for both Windows and Macintosh computers, this is a wise suggestion.

Student Computer Literacy

Another important consideration is whether or not students have the prerequisite literacy skills to participate in the course. For example, if a student has never ‘surfed’ the Internet before they may find learning in this environment challenging. Looking specifically at an online GIS course, students will have to feel comfortable

downloading files and using new software. Since communication through email will be important for this course, students will also have to learn 'netiquette' (Foote, 1997 and Goet & Foote, 1999 Weston et al, 1999).

Infrastructure

Weston et. al. also wisely caution instructors that they need to first determine whether or not there is adequate infrastructure and technical support to maintain the course. This will help to ensure that the delivery of courses through the Internet is fast and reliable. The Ottawa-Carleton District School Board is an example of a board that is capable of supporting an online course as it employs both software and technical support staff. It has also recently upgraded its internal wiring to make Internet connections faster. Currently, high schools in the board receive approximately 10 Mbits per second speed rate or 1MB per second over their connection (Goerz, 2002).

Interactivity

Weston et. al. believe that a good online course is one that attempts to actively engage the students. They suggest a number of ways to do this, such as using: bulletin boards, exercises and quizzes with branching for incorrect answers, interactive discussion groups and simulations (such as online dissections). Both Howard's Multiple Intelligence Theory and Piaget's Constructivist theory, encourage the use of interactivity to engage students in learning.

Navigation

Weston et. al. believe an essential factor when designing a course is to consider how students will navigate throughout the site. Navigation must be intuitive; otherwise students may get lost and become frustrated.

Evaluation

There are many different methods to evaluate students in an online environment, however Weston et al (1999, p. 42) believe that "...the method used in teaching the content must also be used when evaluating learning". For example, if students are taking a course to learn problem solving, then the evaluations should require them to demonstrate problem-solving skills.

Content Accuracy

Since the expectation of Web users is that the instruction is revised and updated frequently, Weston et al (1999) strongly urge instructors to revise and update their sites regularly.

Loading Speed and Bandwidth

While multimedia in an online course is an excellent tool for meeting the needs of Howard's Multiple Intelligences, Weston et al suggest that instructors should first determine whether or not multimedia is necessary for the course. This is an important consideration as multimedia can slow loading speed of a course making loading individual pages time consuming.

Weston et. al.'s (1999) nine guidelines are not the only guidelines available to provide a process for developing an online course, however they have produced a basic overview of what is involved in the design process. Some of these nine guidelines will be explored in greater depth throughout this chapter; other issues not considered by Weston et. al. will also be discussed

CONTENT ACCURACY AND QUALITY

While not the first of Weston et. al.'s (1999) nine guidelines, content accuracy and quality essential element to the design of any course. A course where the accuracy of the content or effectiveness of the content has not been established will not be a successful course. This is a problem with many online courses as "the need to create online space has led to many instructors viewing themselves as 'builders first' and 'teachers second'" (Gillette, 1999 as quoted in Blythe, 2001 p. 329). Design is inevitable, however instructors should concentrate on the pedagogical aspects first to ensure a successful learning environment.

Looking at the Weston et. al.'s (1999) guidelines, content accuracy should be contemplated once the proposed online course has been determined to impact student learning. Weston et. al. (1999, p. 37) believe it is important to ask

whether the content of the course “is relevant..., reliable..., and up to date...”. The importance of these questions cannot be stressed enough, as a well-designed Website does not necessarily equate to a well-designed course if the content has not been examined. As mentioned previously, Weston et. al. (1999) argue it is the expectation of Web users that the instruction is revised and updated frequently; therefore content accuracy and quality and relevance should continually be evaluated. As this creates a heavier workload for instructors, it is essential that the need for an online course is sufficient for the amount of effort and time required to develop and manage it.

Once the content of the course has been evaluated for its effectiveness and its reliability, the instructor should examine how to present it in an online environment. Duchatel (1997) argues that the content needs to be presented “in a fashion which provides authentic examples and contexts” (Duchatel, 1997 as quoted in Oliver, 1999), this follows the constructivist notion of learning which has been argued in this thesis to be an effective form of pedagogy. Online learning provides many opportunities for constructivist learning through its support of student centred practices and ability to relate learning to context (Berge, 1998, Barron, 1998, Oliver, 1999). This learning can further be supported by content that utilizes the multimedia and interactivity capabilities of the Internet so that it appeals to different learning styles.

This second consideration is important as it forces the instructor to consider how the content of the course should be altered to take into account this new delivery system. As mentioned previously, some critics of the Internet have argued that many on-line courses are essentially the same course that can be found in the traditional classroom. Mitchel, Dipetta and Kerr (2001, p.117) put forth a good argument by stating:

One of our concerns with much of the existing literature is that models for developing, integrating, and using online course delivery systems tend to be backward looking. That is, they are based on past experiences with similar or older technologies like educational radio and television. Such approaches equate the new frontier with other frontiers and do no account for the unique features of this new landscape. Sometimes this leads pioneers to think that they can simply take what has worked well for them in the past and strike out to homestead the new territory. From our perspective, this had meant taking what has worked well in a face-to-face course or a distance course and reproducing it for online delivery. Such pioneers of the virtual frontier learn quickly that what has worked for them in traditional classroom settings does not always work in the online environment.

This quote illustrates the need to utilize the technology and not to completely base course design on past distance learning technologies like educational radio or television. Thus, the next section of this chapter will deal specifically with the design of the online course.

DESIGN CONSIDERATIONS

Technical aspects

Weston et. al. (1999)'s nine guidelines provide an overview of technical issues for instructors when designing a course. However, it is also important to consider

some of the more specific technical aspects. Looking at the literature, Barron (1998) is often cited for her useful suggestions, some of which mirror those of Weston et al (1999). These suggestions are:

- Design courses so they can be displayed on a variety of platforms (a view shared by Weston et al)
- Have high contrast between the text colour and background colour to ensure readability (i.e. if using a dark colour for text, choose a light colour for the background)
- Limit the size of graphic files. Barron suggests that graphic files should not be larger than 40K, however her article was published in 1998 when the 28K modem was considered the lowest modem speed for development. With the increased use of high speed Internet, most Web users do not have a modem speed slower than 56K. This may be different outside North America where slower modems are still widely used. Regardless, graphic files should not be so large that it takes longer than 30 seconds for a page to upload.
- Include links to plug-ins if needed (plug-ins are software modules that add advanced features to Browsers)

Articles like the one by Baron are not the only places where useful information can be found on the technical aspects of designing an online course. The Internet, which is the medium that online courses use, is also a valuable source to find information about designing a course.

The University of Wolverhampton in Wolverhampton, UK (<http://www.wlv.ac.uk/celt/oltips/4design.html>) provides the following advice about designing a Website:

- Pick colours for text and background from the 216 Web safe colours. These are colours that are considered useable by both Macintosh and Windows computers. The University suggests examining the work of Lynda Weinman, who is considered to be an expert in the use of colour in Web pages (<http://www.lynda.com/resources/inspiration/>). Her input was

used by Macromedia to determine pre-designed colour schemes for Dreamweaver users.

- Scrolling left and right on a site should be avoided. Screens should therefore be designed for 640 x 480 pixels
- Use of frames should be avoided since they prevent both bookmarking (a tool on many browsers that allows you to list favourite sites) and printing
- Drawings and other pictures with uniform colours should be in .gif format (Graphics Interchange Format)
- Photos and pictures with shading and colour scales should be in .jpg format (Joint Photographic Expert Group)

Navigation

Navigation is an essential design element as users can easily become frustrated if navigation is not intuitive and may discontinue visiting a site. The importance of navigation and its impact on Web users is evident from the prolific research and discussion available in the human and computer interaction literature. One subject in the literature that is discussed extensively deals with contextual information and how it provides information about Web location to the user.

A recent study by Park and Kim (2000) examined how *contextual information* aids users in navigating through a Website. Contextual information is “defined as the explanation of users’ current situation in the Web environment” (Park & Kim, 2000, p. 194). Essentially it provides users with clues as to how the user arrived at a particular Web page (temporal information) and where they can travel to (spatial information). In their study, Park and Kim found that users experienced

less frustration and were more adept at finding particular pages when there was contextual information. Contextual information can take many forms, for example temporal information can be provided by highlighting visited links in a different colour. Spatial information can be provided by having a site map (which illustrates the hierarchy of the site) located on the Website. Yu and Roh (2002) concur with Park and Kim's view and also argue that multi-windows (a link which opens up into another window) and fisheye views (where close objects are magnified and distant objects are shrunk) also help provide context information to users. Research has also shown that if using multi-windows, users' knowledge of their spatial location in the site can be achieved by colour coding the windows according to sections (Vorley, 2001).

Navigational design can also help with enhancing the searching techniques of users. Lai and Waugh (1995) have found that by using embedded menus, users are able to engage in in-depth searching behaviour. Embedded menus are commonly found as links in the text of the page; they can often lead to definitions or related topics.

Visual design of the navigation tools is also an important element of the navigation system. Carlson and Kacmar (1999) argue that links, which employ colour or *graphic bound objects*, are more effective in communicating the existence and extent of the links and are preferred by users. Links that employ

graphic bound objects contain a graphic that is representative of the link, for example a graphic of a question mark could be a link that leads to a help page.

Barron (1998) has also provided some useful guidelines on navigation systems based on her experience as an online teacher. She suggests the following to help aid users in navigating around a site:

- Provide buttons or links that will take the user to the previous page, the next page and the main menu. This will aid students in navigating through the information in the sequence that was intended
- Like Carlson and Kacmar, Barron strongly suggests the use of graphics to provide descriptive clues about where a link will take them

With the variety of navigational aids available designers may be tempted to employ several different navigation techniques. Thus, both Park and Kim (2000) and Yu and Roh (2002) strongly caution designers from creating a navigation system that is too complex, as this will also confuse Web users.

Screen design

The design of a Web page is also an important element in human computer interaction as it can affect a users ability to obtain information from the site. Essentially, the effective use of both text and visuals on a Web page can enhance a students learning experience and improve recall. This design must therefore be based on research as “appropriately designed displays enhance learning. Designed without an understanding of how people gain meaning from

them, displays can have no effect or can even interfere with learning” (Steinberg, 1991, p. 144 as quoted in Kanuka & Szabo, 1999)

Effective use of text is an important element to learning and has been researched extensively in both human computer interaction and in using plain text. Standard Web page design guidelines suggest using headings or “chunking” of information (Shea-Schultz & Fogarty, 2002), as many researchers believe that it helps Web users synthesize information (Taylor, 2000, McCampbell, 2001, Shea-Schultz & Fogarty, 2002). The idea of chunking information on Web pages is not new as it comes from educational theory and the psychology of learning that “chunking” improves comprehension and recall when reading print based text. While many experiments have tested this theory in the past, a recent study was conducted by Duggan and Payne (2001) using instructional guides for a Video Cassette Recorder (VCR). Their research concluded that the group who read instructions that were chunked had better recall than the group who read the non-chunked instructions. Based on this type of research chunking has become standard design for Web pages, however it should be noted that there is a paucity of research on the effectiveness of chunking in hypertext format. Knowing this, chunking does provide a way to organize material according to topic or theme, and thus should theoretically help with the learning process. Taylor (2000, p. 16) clearly outlines this by stating:

...Reading from a computer screen is more tiring than reading from papers and books. If reading is to remain an integral part of...education, reliance on the Web is bound to create problems. Many users tend to navigate through hypermedia information as

quickly as possible. Stress is placed on searching for information (surfing), not on reading long documents. In fact, standard design principles stipulate the Web pages should be no longer than one screen-length, so surfers will not have to scroll. When faced with long Web-based lectures, students are likely to become impatient and skip ahead.

The presentation of text on Web pages is also further enhanced if it is concise and uses proper spelling and grammar. Kanuka and Szabo (1999) suggest that this gives credibility to a site.

Skaalid (2001) has provided some useful guidelines about screen design based on her own experiences in Web page design and on researching the literature. Some of these are:

- Have consistency in menus, fonts, colour, layout
- Use fonts like Verdana and Georgia as they are easy to read on the screen
- Wild backgrounds disrupt reading
- Use visuals that complement the text

Barron (1998) also has some useful ideas on creating Web pages for online learning. She suggests that:

- Course objectives should be placed first and made prominent
- Limit the length of Web pages. "Web designers agree that the initial page of a Web site should not exceed one page...On other sections of the course (past the initial page) a good limit seems to be 1 – 3 screens in length" (Barron, 1998, p. 36)

MOTIVATION

While not mentioned by Weston et al (1999) as a factor in the design process, motivation is a key concern in online courses because of the high drop out rate. According to the virtual high school that was involved in a study by Robyler (1999), as many as 40% of the students will drop out of a course. The literature contains many suggestions about how instructors can motivate their students so that drop out rates are minimised. Rourke (2001) suggests that teachers should restrict online courses to students who are considered to have an appropriate fit to learning online. The characteristics of students who succeed well in an online environment were outlined in Chapter Three, but Rourke also suggests the most important student characteristic is to be active about their own learning. He argues that students do not have to be high achievers in a regular classroom, but they do have to be willing to take responsibility for their own learning. As indicated earlier in Chapter Three, many of the students who performed well in an online classroom were those who were failing in a traditional classroom. However, knowing whether or not a student will take an active interest in their learning in an online course is a challenging task. Thus, instead of restricting access to online courses to certain students, teachers should have a section listing characteristics of a successful online student. This practice is something that the author noticed was done when taking her online courses at Algonquin College.

Schrump and Hung (2002) have outlined five categories for teachers to help motivate their students. They believe that by providing a greater sense of community, students will be motivated to participate in the class. These categories are as follows:

Socializing

A sense of community helps to motivate students. Schrum and Hung (2002, p. 12) suggest encouraging "...students to post a short autobiography at the beginning of the course to make them feel they know each other". This suggestion is something that can be found throughout the literature including articles by Foote (1997), Wang et al (2001) and King (2002). This was also the practice in an online Visual Basic course the author took at Algonquin College.

Support

Interaction with students helps to motivate them and keep them on track with the course. Schrum and Hung (2002, p.12) state to facilitate this educators should "...interact with students on a one-to-one and regular basis, especially for those who (fall) behind". They also state that course designers should create a space where students can communicate and ask each other for help.

Interaction

Interacting with other students also creates a sense of community and helps to motivate students. To encourage interaction, Schrum and Hung (2002) argue that students should share their individual course work. This provides students with a sense that there are others in the class and also students benefit from the feedback they receive from their classmates. They also suggest that some projects should be collaborative projects and that instructors should set minimal levels of participation.

Flexibility

Schrump and Hung (2002) also believe that flexibility in educators is essential for students to feel a sense of community. By allowing students to have some say in course topics or structure of the course, students will feel like they have greater control over their learning and be more motivated to participate in the class.

Minimizing technological difficulty

Finally, Schrum and Hung (2002) state that by minimizing the technology used in the course, you reduce the technological requirements and difficulties. As stated previously in Chapter Three, students experience frustration and are more likely to drop a course if they are having difficulties with the technology.

When dealing with high school students many of the suggestions for adult learning, like the ones stated above, can be implemented but it is important to consider the specific motivation techniques that appeal to teenagers. Wang et. al. (2001) conducted a study in the United Kingdom looking at how teenagers react to collaborative learning in an online environment. They found that the most significant motivation "...for the participants to stay engaged in the project was the social interactions they developed with team members" (Wang, 2001, p. 211). This is a view that is shared by Schrum and Hung for motivating adult learners.

Online high schools also have their own techniques for motivating students. The Florida Virtual High School attempts to keep students on track by requiring them to submit a project report at the beginning of each module for the course. The student must outline what days he or she will work on a lesson and for how many hours. Teachers have guided students in this by providing information about how many hours each assignment will take. By providing a project report, high school students will have some structure to what their day will be like and will not become overwhelmed by taking total responsibility for their learning.

While high drop out rates are common for online courses, using some of the methods suggested above has proven to keep drop out rates to a minimum.

Annette Levesque, online teacher with the Ottawa-Carleton District School Board has found that engaging her students and providing a means for interaction has made the drop out rates for her courses minimal. By developing a good rapport with her students through email communication, Levesque had 23 out of 25 students finish her first online course (Levesque, 2003).

TEACHING STYLE

While much has been written about learning styles, teaching styles of instructors also have a huge impact on the effectiveness of the online course, however this view is often ignored in the literature. Just as not every student is suited to this style of learning, not every instructor is suited to this style of teaching. It is therefore important that an instructor's teaching style be examined, as a poor online teacher will create a poor online learning experience for students. Volery (2001) has outlined some basic characteristics online teachers should possess; these are:

- A positive attitude toward online learning
- Able to encourage interaction among students
- A good understanding of the technology and the ability to perform basic trouble shooting tasks
- Good organizational skills due to the intensity of teaching in this environment.

Both Berge (1998) and King (2002) argue that a teacher should also favour student-centred learning in their educational philosophy. Instructors who are

more comfortable teaching in an instructed centred environment will not be effective teachers in an on-line learning course, as the Internet is a medium that lends itself to individualized learning. Teachers should also feel comfortable using problem solving and inquiry based teaching methods in their lessons (King, 2002). A teacher who favours these two methods and student-centred learning follows the collaborative learning model, which has proven to be an effective learning model in online learning

EVALUATION OF THE COURSE

The final step in course design should be the evaluation of the course, however this step is not an endpoint, as a course should be evaluated continuously throughout its lifecycle. It is also a step that is often ignored in the literature when discussing the process of designing an online course. This could be due to the fact that adopting criteria to evaluate a course is a challenging task especially since “the expansion of distance learning opportunities has come so fast that measures of quality for such factors as course offerings, pricing, learning outcomes and academic support are not long-standing normative values” (Novak, 2002 p. 80). So how do we evaluate? One of the most cited evaluation measures in the literature comes from an Institute for Higher Education policy study commissioned by the National Education Association (U.S) and Blackboard Inc. (one of the top business providers of a software platform for delivering online courses). This study identified 24 benchmarks to help ensure quality and consistency of online learning (see table 4.1)

Table 4.1 Institute for Higher Learning Measures of Quality in Online Learning

Institutional Support Benchmarks
1. A documented technology plan that includes electronic security measures to ensure both quality standards and integrity and validity of information
2. The reliability of the technology delivery system is as failsafe as possible
3. A centralized system provides support for building and maintaining the distance education infrastructure
Course Development Benchmarks
4. Guidelines regarding minimum standards are used for course development, design, and delivery, while learning outcomes - not availability of existing technology – determine the technology being used to deliver course content
5. Instructional materials are reviewed periodically to ensure they meet program standards
6. Courses are designed to require students to engage themselves in analysis, synthesis, and evaluation as part of their course and program requirements
Teaching/Learning Benchmarks
7. Student interaction with faculty and other students is an essential characteristic and is facilitated through a variety of ways, including voice-mail and/or e-mail
8. Feedback to student assignments and questions is constructive and provided in a timely manner
9. Students are instructed in the proper methods of effective research, including assessment of the validity of resources
Course Structure Benchmarks
10. Before starting an online program, students are advised about the program to determine if they possess the self-motivation and commitment to learn at a distance and if they have access to the minimal technology required by the course design
11. Students are provided with supplemental course information that outlines course objectives, concepts, and ideas, and learning outcomes for each course are summarized in a clearly written, straightforward statement
12. Students who have access to sufficient library resources that may include a 'virtual library' accessible through the World Wide Web
13. Faculty and students agree upon expectations regarding times for student assignment completion and faculty response
Student Support Benchmarks
14. Students receive information about programs, including admission requirements, tuition and fees, books and supplies, technical and proctoring requirements, and student support services.
15. Students are provided with hands-on training and information to aid them in securing material through electronic databases, inter-library loans, government archives, news services, and other sources
16. Throughout the duration of the course/program, students have access to technical assistance, including detailed instructions regarding the electronic media used, practice sessions prior to the beginning of the course, and convenient access to technical support staff
17. Question directed to student service personnel are answered accurately and quickly, with a structured system in place to address student complaints
Faculty Support Benchmarks
18. Technical assistance in course development is available to faculty, who are encouraged to use it
19. Faculty members are assisted in the transition from classroom teaching to online instruction and are assessed during the process
20. Instructor training and assistance, including peer mentoring, continues through the progression of the online course
21. Faculty members are provided with written resources to deal with issues arising from student use of electronically-accessed data
Evaluation and Assessment Benchmarks
22. The program's educational effectiveness and teaching/learning process is assessed through an evaluation process that uses several methods and applies specific standards
23. Data on enrolment, costs, and successful/innovative uses of technology are used to evaluate program effectiveness
24. Intended learning outcomes are reviewed regularly to ensure clarity, utility, and appropriateness

Source: Quality on the Line: Benchmarks for Success in Internet-Based Distance Education, March 2000, The Institute for Higher Education Policy as quoted Wagner, June G. (2001). Assessing Online Learning. Keying In. 11(4): 1 - 8

While these benchmarks were created for post-secondary education, they can be adapted for secondary education since their focus is on pedagogical and curricular issues; other guidelines incorporate benchmarks that examine marketing considerations that would not be as useful to a secondary school program (Novak, 2002). While these benchmarks provide an excellent means to evaluate a course, they should not be viewed as static. Novak (2002) argues that researchers should acknowledge that “distance education is an evolving medium and what we call distance education will probably be unrecognizable ten years from now”. Therefore, benchmarks, like those in the IHEP study, should be adjusted to meet the needs of the continually evolving realm of online learning.

CASE STUDIES

Much is written in the literature about how online courses should be designed and this has been explored extensively in the previous sections of this chapter. However, to understand how ‘real-world’ design for an online GIS course for grade 12 students could operate, three cases studies will be examined. These are: The Geographer’s Craft from the University of Colorado, ESRI’s Virtual Campus, and Florida Virtual High School.

The Geographer's Craft

<http://www.colorado.edu/geography/gcraft/contents.html>

The Geographer's Craft is a course that uses problem based learning to teach about GIS, cartography, remote sensing and spatial analysis (see figure 4.1). Offered through the University of Colorado, the course places all materials, resources and assignments on the Web. Kenneth Foote, who is the instructor of the course, has described in several papers (Foote, 1997 and Goett and Foote, 2000) how the course is organized. Foote (1997) has organized his site into four different sections, which help students find the information they are looking for.

These sections are as follows:

General Information

This includes information such as the course syllabus, schedules for each semester, student and staff directories and rules for lab access

Lecture Notes, Laboratory Exercises, and On-Line Discussion

Foote (1997) notes that this section took up most of the development work since it contains links to lecture and discussion notes and to exercises and problems. Lecture notes are divided into 14 modules and cover topics ranging from Map Projections to Aerial Photography.

Internet Resources and Helpful Information

This section includes Web resources on GIS and geography. Students can contribute to this list or note links that are broken for extra credit. Help files are also included as part of this section to complement the help files provided with the computer applications used in the lab.

Class Projects on the Web

The final section provides links to projects students have published on the Web.

Foote (1997) also describes how he runs the course, focusing mainly on how he attempts to enfranchise the students. He believes that students have a better

learning experience if they feel they are part of the course and have some say in how it is run. He enfranchises the students in several ways, one of which is to use the University's free email system. Email is used in the course for communication, collaboration and for submission of assignments. To encourage its use, tasks are assigned during the first few weeks that require students to use email extensively. This has two purposes, the first is to promote this method of communication and the second is to teach netiquette (or how to use email for professional communication and collaboration). For example, in the first exercise of the course students are required to send a hello message to the teaching assistant (T.A.) and to ask the instructor a specific question about the content of the course.

Figure 4.1 Geographer's Craft Homepage

lecture and discussion notes
problems and exercises
fall schedule
spring schedule
study questions
visitor's guide

The University of Colorado at Boulder
GEOGRAPHER'S CRAFT

BEST OF THE NET
The Global Positioning System Overview, part of The Geographer's Craft Project, written by Peter H. Dana, has been selected as one of GIS World's eight "Best of the Net" sites for 1996.

national science foundation

You are welcome to use and copy these materials for education, but please credit the source as: *The Geographer's Craft*, Department of Geography, University of Colorado at Boulder and cite the individual author of the modules you use. All commercial rights are reserved. Send comments or suggestions to the principal investigator: Dr. Kenneth E. Roote at k.roote@colorado.edu.

All Geographer's Craft materials were moved to the University of Colorado at Boulder during spring and summer 2000. The course is not presently offered at the University of Colorado, but the materials will kept online for use in other classes at CU and elsewhere.

1. General Information

[Course Syllabus](#) | [Fall Semester Schedule](#) | [Spring Semester Schedule](#) | [Class Directory](#) | [Lab Teams](#) | [Directory of Lab Staff](#) | [Gradesheet](#) | [Guidelines for Laboratory Access and Use](#) plus FAQ and Chat Room | [Information about the Geographer's Craft Project](#) | [How to Enroll](#) | [Prerequisite Windows and Internet Quiz](#)

2. Lecture Notes, Laboratory Exercises, and On-Line Discussion

[Lecture and Discussion Notes](#) | [Warm-up Exercises](#) | [On-Line Class Discussion Board](#) | [Sample Examination and Study Questions](#)

< <http://www.colorado.edu/geography/gcraft/contents.html> >

A second method Foote uses to enfranchise his students is the use of student homepages where they can publish their work and share their findings” (Foote, 1997). Foote has found that if students are required to publish their projects on the Web, they exert greater care in what they publish as they realize this is not just for their professor’s eyes. Foote notes that students have been rewarded with suggestions and comments from all over the world on their projects, making them feel like participants in a larger community. Foote also publishes a student directory on the site so that students can contact classmates easily, providing them with a sense of a class community.

Figure 4.2: Lecture Notes for the Geographer's Craft

http://www.colorado.edu/geography/gcraft/notes/datacon/datacon_f.html

<http://www.colorado.edu/geography/gcraft/notes/gisapps/reengr.html>

The Geographer's Craft has many well thought out lessons and lectures that make this an excellent example of how an online GIS course should be

structured. Exercises include topics such as: mapping cholera outbreaks in Peru, examining environmental and physical barriers in urban centres for the physical disabled and mapping archaeological digs. However, the design of the Web site could be improved upon to make this course more appealing. While many of the pages on the site share the same look, not all of them do making the user feel like they are visiting another site. A perfect example of this is in the lecture and discussion notes section, which contains a series of articles written by different authorities on a particular subject. Some of these pages include frames, some do not; some are white and some are blue; some include navigation links along the left hand side of the site and some do not have any navigation buttons (see figure 4.2). The lack of consistency of the site harms what is otherwise an excellent course.

ESRI Virtual Campus

<http://campus.esri.com/index.cfm>

ESRI Virtual Campus is an online community created by ESRI, an international company that produces popular GIS programs. The courses are geared to using ESRI products like ArcView and ArcInfo. Courses are not free; they range in price from \$60USD to \$300USD. However, it is possible to take a free module of a course to test it. These online courses are particularly useful to look at since ArcView is licensed for Ontario schools. As noted previously in Chapter Two, many high schools in the United States use the Virtual Campus to teach students about GIS and its uses.

To examine the campus as a model for high school students who are only beginning to learn GIS, the first module for the course “Introduction to ArcView 3.x” was examined (see figure 4.3). This course is divided into six modules: Basics of ArcView, Querying data in ArcView, Working with Tables in ArcView, Analyzing Spatial Relationships in ArcView, Presenting Information in ArcView and Creating Your Own Data in ArcView. Students are required to have ArcView 3.x on their computer, which is provided free for 60 days with the purchase of this course.

Figure 4.3 ESRI Virtual Campus: Introduction to ArcView 3.x Module

<<http://campus.esri.com/campus/myoffice/mycourses/CourseHome/index.cfm?c=1&CFID=4573272&CFTOKEN=60402124>>

The first module, Basics of ArcView, is the free module for the course and is divided into three lessons: Introducing ArcView, Getting data into ArcView and Displaying Themes. Knowledge is tested by an exam at the end of the module. The lessons use no frames and are divided into easy to read subheadings or “chunks”. As mentioned previously in the design consideration section, the literature suggests avoiding the use of frames and to chunk information into headings. There are also many graphics along the way to provide guidance in the course, which downloaded quickly from a high speed Internet connection.

The Virtual Campus also tries to establish a sense of community through the posting of various GIS clubs members can join (i.e. industry specific clubs or region specific clubs) and through an email system where you can contact or be contacted by others taking a Virtual Campus course.

ESRI Virtual Campus is a well-designed learning community. Its pages are well organized and consistent making it very easy for the user to navigate. While an excellent example of how a learning community should be designed, it is not well suited for high school students. The lessons lack excitement, which is essential to engage students of this age. They also rely heavily on exams, making it very easy for students to cheat. The site is also not designed to ensure the safety of high school students since non-high school students can easily contact them. Ensuring safety of students in an online environment has become an important policy of many school boards.

Florida Virtual High School

<http://www.flvs.net/>

Florida Virtual High School began as a pilot project by the Florida State government in 1997. By 2000 this pilot project turned into one of the largest online high schools offering 56 courses from grades 9 to 12, with an enrolment of 4 6000 (Rourke, 2001). The school is affiliated with all school districts throughout Florida and numerous charter and non-public schools (Rourke, 2001). The school establishes a community environment by having areas for discussions, chats, and even school clubs (i.e. newspaper club, junior classical league club). Like ESRI Virtual Campus, outside users can view online courses by testing one module of a course. Unlike ESRI Virtual Campus there are tighter restrictions about being able to contact other students. Outside users can view the discussion board format but are not able to see messages nor are they able to post messages. The chat section is also completely unavailable to outside users.

While a GIS course is not yet available, there are many courses ranging from English to programming. To best exemplify what a GIS course could be like in this environment, the HTML course was viewed, since it is also a technology course (see figure 4.4).

The HTML course is designed to engage young adults as its structure is less serious than that found in the ESRI Virtual Campus courses. Students are

informed that they are new workers for an organization and they are going to be trained in using HTML. To facilitate this environment, the sections of the course have been given names that correspond to a work environment. Hence, the section entitled time clock tells students how much time they should devote to each project, the section entitled payroll gives the breakdown in marks, and the section entitled storeroom is where students can obtain the graphics and software to use in the projects.

Figure 4.4 Florida Virtual School: Introduction to HTML programming

<<http://online.eeducation.com/jsp/navbar/NavBarShowDefault.jsp?stateID=7673194139039311344930048309133>>

Navigation is also aided in this course by using graphic objects that provide clues to where a page will lead. For example, the chat link is a graphic of two people talking (see figure 4.4)

Like the other online learning environments, the courses are divided up into modules and again into lessons. The Florida Virtual High School accomplishes this by listing the modules and having drop down menus for the lessons. The first module, which is unavailable for viewing, provides students with an orientation of the site and information they need to know to learn on-line. The module that was available for viewing is module three, "Creating Images". This module contains one lesson with 10 projects in the lesson. All projects were easy to understand with explicit instructions. Students gained experience in how to save images from the Internet to how to create their own animated .gif

The Florida Virtual High School is an excellent environment for students of high school age. It attempts to engage students by appealing to their needs as well as creating courses with interesting formats. The one negative aspect of the Florida Virtual High School is that it requires the Flash plug-in (a plug-in that allows Web users to view content create by Flash, a popular authoring tool for vector based graphics) to properly view the site. While most Web users have the Flash plug in installed, not many schools (including Carleton University) do and this can cause problems for students wishing to view the site.

CONCLUSION

Designing an online GIS course for high school students requires a well laid out plan that uses knowledge from the literature, experiences from online learning,

and the needs of the students. As discussed earlier, the most important consideration is to develop content that is relevant, reliable and accurate. The lessons should also provide the means for students to learn in their own context, thus following the constructivist paradigm of learning. Looking specifically at GIS education this means providing students with lessons that allow them to explore geographic concepts about GIS, rather than learning GIS. This view was discussed in more depth in Chapter One. Lessons should also teach students how to interact online. Thus, one of the first projects students should be involved in is one that teaches them about netiquette as well as how to evaluate Web resources.

Learning to interact online leads to one of the most significant suggestions found in the literature for creating a successful online course, which is the course must be interactive. There are many ways this can be done from creating online bulletin boards to developing a class directory where students can write short autobiographies about themselves.

Navigation is also an essential element in an online course since a badly designed navigation system will discourage students from using the site. Navigation elements to employ include: multi-windows, embedded links and graphic bound objects. However, the most vital factor when designing a navigation system is to ensure that it is not too complicated.

Finally, it is essential to consider the practical design elements of an online course, such as the Internet connection used by the students, size of graphics, and the type and amount of multimedia to use. A prototype of a GIS course for high school students will be examined in the next chapter.

CHAPTER FIVE

GEOTECHNOLGIES IN ACTION: THE ONLINE COURSE

INTRODUCTION

This chapter will introduce the prototype online course for Geotechnologies in Action (Appendix B). In an attempt to demonstrate how this course could be a viable option to fill the gap in GIS education in secondary schools this chapter will describe: the course and its content, the steps in creating the course, specific features of the course and why they were chosen, and finally some of the limitations of the prototype and how they can be addressed in the creation of a fully implemented online course.

Only a prototype course is presented here as the design of a fully developed course is beyond the scope of a Master's thesis. A full online course with interactivity and newly developed lessons is estimated by the author to involve 400 hundred hours of work. It is assumed that the teacher creating an online course for Geotechnologies in Action would already have developed lessons for this course or similar courses, and thus the time involved in creating the online version would be minimized. This prototype is designed to outline the structure and content of a full in-school online GIS for high school students in Ontario.

COURSE DESCRIPTION FOR GEOTECHNOLOGIES IN ACTION

The grade 12 course Geotechnologies in Action is an excellent choice to illustrate an online GIS course as it allows teachers and students to explore many components of Geomatics, one of which is GIS. The Ontario Ministry of Education defines the course objective for Geotechnologies in Action as:

Geotechnologies in Actions examines the approaches and techniques that geographers and other professionals use to acquire, manage, map, analyse, and communicate information about the earth's surface. Students will receive a systematic introduction to the four pillars of geomatics – surveying, remote sensing, cartography, and geographic information systems (GIS) – and will learn how to apply their knowledge and skills to a variety of real-world situations relating to physical and human geography (Public District School Board Writing Partnership, Spring 2002, p. 1).

Geotechnologies in Action is structured as a University/College level course. The new Ontario secondary school curriculum offers four different levels of courses at grades 11 and 12 based on a student's direction after high school. These four levels are: workplace, college/university, college, and university. The Ontario Ministry of Education describes a college/university course, like Geotechnologies in Action, as follows:

University/college preparation courses are offered to...meet the entrance requirements of certain university and college programs. They focus on both theory and practical applications (<http://www.edu.gov.on.ca/eng/document/brochure/stepup/choosing.html>).

THE STRUCTURE OF GEOTECHNOLOGIES IN ACTION

The structure of this course will be based on the *Course Profile* for Geotechnologies in Action. Course Profiles are sample courses produced through partnerships of school boards and subject associations and funded by the Ontario Ministry of Education. They have been written for teachers by teachers and have been reviewed by the Ministry of Education for consistency with policy (<http://www.curriculum.org/occ/profiles/profiles.htm>). The Course Profiles develop a structure of the course and then create *one* unit of the course complete with lesson plans. The Course Profile for Geotechnologies in Action has created the following units, of these, only unit three has been fully developed:

Unit One: The Fundamentals of Geomatics

Unit Two: Geographic Concepts Using Imagery

Unit Three: Analysing and Understanding Patterns of Information

Unit Four: Using GPS and other Geotechnologies in the Field

Unit Five: Culminating Unit: Analysis of an Issue Using Geomatics and Geotechnologies

The Course Profile has designed the content of Geotechnologies in Action so that students are taught about the geographical principles behind GIS, and does not focus on training students how to use a GIS. The overall expectations for the course, as outlined by the Ministry of Education, focus on spatial concepts rather than specific programs. These overall expectations are:

- Explain how the earth is modelled for scientific and mapping purposes;
- Demonstrate an understanding of basic spatial concepts;

- Explain the process of map projection and the properties and uses of selected projections;
- Explain the use of geotechnologies in studying physical and human systems;
- Use geotechnologies effectively to display and analyse patterns and regions on the earth's surface (Public District School Board Writing Partnership, Spring 2002, p.13)

It was argued in Chapter One that it is essential for students to understand the geographical concepts behind GIS and not only be trained in using a specific GIS program. By understanding geographical concepts, students should be able to take this knowledge and use it in any GIS program.

Some training, however, is needed at the secondary level if only to adequately use a GIS. Foote (1997) has achieved success in his undergraduate GIS course by using GIS in problem-based projects. Using this method, students gain an understanding of both the concepts behind GIS and how to use a GIS. The online version of the Geotechnologies in Action course should begin by providing students with a background in geographical concepts and then approach GIS training through problem-based projects.

SOFTWARE AND DATA FOR THE COURSE

The GIS software to be used in the prototype is ArcView 3.1 or 3.2. for Windows. As the author does not have access to a Macintosh computer, this course will be limited to those schools that have Windows computers. As mentioned previously, the course will be designed as an "in-school" online course because

of the licensing agreement the Ontario Ministry of Education has with ESRI Canada. Unfortunately, the licensing agreement does not allow students to take ArcView home to install on home computers. As a student license for ArcView costs \$450CDN, an online GIS course for home-schooled students is not viable for most students because of the high cost.

Data is also essential to use a GIS, and there is a considerable amount of free data available on the Internet. However, not all free data available on the Web is accurate or reliable. The Ontario Ministry of Education has licensed ESRI Canada's ArcCanada 2.0 for all elementary and secondary schools in Ontario, but the agreement does make this source of data available for students to use at home. Since ArcCanada 2.0 costs \$99CDN (Kelly, 2002) it provides another reason for restricting this course to in-school students. While many secondary schools are now charging a class fee to cover the costs of photocopying and other resources, \$99CDN is an exorbitant fee for one course in the public education system.

SOFTWARE USED IN THE CREATION OF THE COURSE

The online environment has been built using *Macromedia DreamWeaver 4*, *Macromedia Flash 5*, and *Adobe Photoshop 5.5*; all programs are industry standards in Web design. *Hypersnap-DX 5* was also used to build this site.

DreamWeaver 4

Is known as a WYSIWYG (What You See IS What You Get) Web development tool. It allows users to create well-designed pages without having to write in HTML code.

Flash 5

Is a tool for creating animation and interactivity in Websites. Many Websites now employ Flash as an introduction to their site or in the use of dynamic flash buttons. To view Flash material, users need the Flash player installed on their computers, which can be downloaded free from the Macromedia Website. At the time of writing, the newest player available is Macromedia Flash Player 6.

Adobe Photoshop 5.5

Is a professional graphic editing tool. It allows users to create their own graphics or to manipulate graphics capture from software programs or from the Web. It is used not only for creating graphics for the Web, but also for print material.

Hypersnap-DX 5

Is a *shareware* screen capture program. Shareware is software that is either distributed free on a trial basis with the understanding that the user will have to pay for it later or distributed free with certain capabilities missing. In the case of Hypersnap, a stamp appears on screen captures of large images. Since the program was used only for the capture of tools or small sections of a screen this

stamp did not appear. When large sections of a screen were needed, the alt/print screen keys were used and the image was pasted into Adobe Photoshop 5.5.

Similar software is available to teachers in Ontario. The Ministry of Education recently licensed Macromedia Studio MX, making it available for all public elementary and secondary schools. It is also available for teachers to install at home for educational purposes. Macromedia Studio MX includes DreamWeaver MX and Flash MX, as well as several other Macromedia products. The MX line is the newest product line from Macromedia, thus it is more recent than the products used for this course prototype. The Ministry has also licensed Adobe Photoshop 5.0 LE, making it available for all public elementary and secondary schools. Photoshop 5.0 LE does not have the same capabilities as Photoshop 5.5, but for the purposes of this site, teachers would be able to duplicate the same result in 5.0 LE as in 5.5. Like DreamWeaver Studio MX and ArcView 3.x, teachers are allowed to install Photoshop 5.0 LE at home for educational purposes.

CHARACTERISTICS OF THE STUDENTS

Before designing an online course it is essential to understand the users for whom it is being created. To explore the user community for Geotechnologies in Action the following categories are used: the age of the students, their GIS knowledge, their knowledge of geographical principles and their computer literacy:

Age of Students

In the grade 12 Geotechnologies in Action course, the age of students can range from 15 to 19, but will typically be between the ages of 17 to 18. It is assumed that students of this age group have reached the maturity required to be responsible for their own learning, however some guidance should be provided to keep students on task.

GIS Knowledge

As this course is a university/college preparation course and as it is structured for students in their last year of secondary school, it can be assumed that students are registered in Geotechnologies in Action because of an interest in pursuing GIS or Geomatics in their post-secondary studies. According to the new Ontario curriculum, students should have been exposed to GIS at some point during the mandatory grade nine course: Geography of Canada. However, the exposure they received depends on their grade nine geography teacher and the computer facilities available. Several years may also have passed since they used a GIS, and therefore, much of their prior knowledge may have been forgotten. In structuring the course it is assumed that this is the students' first exposure to GIS.

Geographical Knowledge

Since Ontario students are required to take only one geography course at the secondary level, several years may have passed since they were exposed to fundamental geographical concepts and principles. The prerequisite for *Geotechnologies in Action* is any university, university/college, or college preparation course in Canadian and world studies, English, or social sciences and humanities. This means that students do not need a grade 11 geography course to take *Geotechnologies in Action*. A refresher in basic geographical concepts is therefore needed.

Computer Literacy

The typical high school student has grown up using a computer both in the home and at school. Students have become accustomed to learning through computer games and CD-ROMs, which teachers have utilized to teach about history, geography, science and a variety of other subjects (Veldof & Beavers, 2001). The Internet is also becoming a source of learning in the classroom. While the author was employed as a high school teacher with the Halifax Regional School Board, she employed many of the tutorials that can be found on the Web to teach her students about different geographical subjects. The Web, which was created in 1992, has existed for over ten years, a significant proportion of a teenager's life. According to Veldof and Beavers (2001), typical American students age 10 -17 have spent nearly one-third of their lives on the Internet. In

Canada, Internet use among teenagers is also very common as 90% of teenagers aged 15 -19 have used it (Dryburgh, 2000).

CONTENT FOR THE ONLINE COURSE

As explained in detail in Chapter Four, content should be the first consideration when designing an online course. What should be taught (i.e. the curriculum) and how it should be structured should be looked at first, followed by the individual lessons and their content. Next courses should be evaluated for their reliability, followed by contemplating ways to present the lessons in an online format. Since the Ontario Ministry of Education has already established the curriculum for *Geotechnologies in Action*, the first task has already been dealt with. The second task, the design of the course structure, has also been established and can be seen in the course profile for *Geotechnologies in Action*. The structure of the online environment does not deviate greatly from that outlined in the course profile, however the needs of the online environment must be considered. Taking advice from researchers like Foote (1997), Goet and Foote (2000), a sixth unit has been created that focuses specifically at learning in the online environment.

Lessons and content were first developed on paper. Both ideas for lessons and their accompanying content were first researched through examining Websites, online courses, classroom textbooks and through a literature search. Because of the substantial time required to complete a functional online course and given

that only a prototype was being developed, only unit one and unit two have been created. The units for the online course are as follows:

Unit One: Learning Online

Unit Two: The Fundamentals of Geomatics

Unit Three: Geographic Concepts Using Imagery

Unit Four: Analysing and Understanding Patterns of Information

Unit Five: Using Geotechnologies in the Field

- This unit name has changed from the one used in the course profile (*Using GPS and Geotechnologies in the Field*) as it should not be assumed that all secondary schools within Ontario have access to a GPS

Unit Six: Culminating Activity: Analysis of an Issue Using Geomatics and Geotechnolgy

CONTENT FOR THE COURSE: UNIT ONE

Unit One: Learning Online provides students with skills necessary to learn in an online environment and to ensure a degree of comfort in this environment. The rationale for the lessons is as follows:

Lesson One: Netiquette

Since the vast majority of communication will be through email, chats or bulletin boards a lesson on netiquette is essential. This lesson also attempts to combine social interaction by requiring students to write a short biography of themselves, which will be placed in the *Classmates Profile* section. As explained in Chapter

Four, providing ways for students to feel less isolated will help to motivate them in the course.

Lesson Two: Using WinZip

This lesson provides students with an opportunity to experiment with the utilities that will be used throughout the course. A lesson on WinZip was developed as an example. As explained in Chapter Three, many students will drop the course if they feel frustrated with using the technology. Through providing mini tutorials on the utilities used in this environment it is hoped that this frustration is minimized.

Lesson Three: Evaluating Online Resources

Since most learning will be online, a lesson on evaluating Web resources was also developed. Students may often visit sites as a place to seek information; this lesson helps them to recognize the potentials and pitfalls of relying on Web-based resources. This lesson also provides a lead in to a subsequent lesson that evaluates the reliability of spatial data. Since students have more experience with Websites than spatial data this provides a backdrop for the types of inaccurate information that can be found on the Web.

Unit One: Learning Online provides many opportunities to introduce students to online learning, an essential component since for many students this will be their first online course. Lessons provided in this online prototype are only examples; other lessons can be developed that introduce students to the bulletin board or to

using the chat feature. Based on the needs of the students, lessons should be adapted to ensure that students begin the course with an understanding of how to learn in this environment.

CONTENT FOR THE COURSE: UNIT TWO

The lessons for Unit Two were designed based on the lesson titles provided by the course profile for Geotechnologies in Action. As mentioned previously these lessons have not been fully developed, nor have they been explained. However, the course profile describes this unit as:

Students explore the structure and concepts used to construct both traditional maps and maps made with a GIS. Students gain an overall understanding of the history of mapmaking and the tools and techniques used for geographic analysis. It is important to emphasize that even though students use technology in mapmaking, the basic underlying principle is that the features on maps represent the natural phenomena in earth thus reinforcing the sanctity of life. This unit should include a basic understanding of map projections and how manipulating map projections can alter our perception of the world. Students are introduced to the primary functional concepts of a GIS – mapmaking, using a variety of themes, ordering layers, using text annotations, and performing the layout of a map. Included with the understanding of a GIS are the introductions to complementary computer programs such as spreadsheets and drawing and graphical packages used in combination to produce well designed and functional maps (Public District School Board Writing Partnership, Spring 2002, p. 3)

The online prototype for Unit Two used this description as an example for creating lessons. It also attempts to introduce students to the five facets of geomatics (Cartography, GIS, GPS, Land Surveying, and Remote Sensing) as this is also an introductory unit to the concept of geomatics.

The rationale for each lesson is as follows:

Lesson One: Introduction to Geomatics

As the majority of the students are in their final year of high school, the first lesson deals with education and career choices in the geomatics field. Not only is this practical information for students, it is intended to generate greater interest in the course by helping students understand that geomatics is a viable subject in the real world. The first lesson also helps students to learn about the five facets through exploring these career and educational opportunities.

Lesson Two: Mapping and the History of Map-Making

The second lesson of the course is intended to illustrate the importance of maps throughout history, and hopefully to provide an understanding of map-making in the future. As this course is intended to be an overview of geotechnologies, this history is only briefly considered.

Lesson Three: Map-Making with a Purpose

As it may be several years since students were taught basic geographical concepts, this lesson is designed as a review. Some of the concepts reviewed include: scale, latitude and longitude and projection (not all of these concepts have been fully developed in the prototype). Each of these modules will be discussed in greater detail:

Downloading Data: Since there are viable sources of spatial data free on the Web, such as data on Ottawa from the city of Ottawa, this module teaches students how to download data.

How to Open ArcView: This module teaches students how to open up ArcView and begin a new project.

Scale: This module, which has been fully developed, illustrates to students the difference between large scale and small scale maps. Using ArcView, students examine two maps to see what a large scale map looks like and what a small scale map looks like.

Latitude and Longitude: This module, which has not been fully developed, should begin by explaining the geographic coordinate system. It will illustrate in a graphical example the lines of latitude and longitude, the equator and the prime meridian. To exemplify this in ArcView, students download the transportable project "projections.apr" from the ESRI Canada Website. The lesson requires students to record latitude and longitude for cities across Canada.

Map Projections: This module, which has not been fully developed, should begin by explaining what map projections are and the types of spatial distortion caused by map projections. It will then provide examples of common map projections such as Lambert Conformal Conic, Peterson, Mercator etc. and explain what they are used for and what spatial distortions they can cause. Students will achieve a greater understanding of map projections by using different projections for countries at various latitudes and maps of different scales. Data for this lesson comes from the ArcCanada 2.0 CD-ROM.

Cartographic Display: This module, which has not been fully developed, should teach students proper cartographic display. This lesson will involve students using ArcView to fix maps that are cartographically incorrect and provide an explanation as to why they are incorrect. It will require the teacher to create a transportable project for students to download.

Lesson three provides students with their first opportunity to see a GIS, in this case ArcView 3.x, without specifically training students on how to use the software. Showing students what a GIS is provides students with context for the

information presented in lesson four, which looks at what a GIS can do in real world situations.

Lesson Four: What is GIS

Using a PowerPoint presentation adapted from ESRI Canada's Schools and Libraries program, this lesson illustrates to students how a GIS operates and what it can do in real world situations. The fully developed lesson should then involve questions based on this PowerPoint presentation as well as an introduction to the geographic inquiry model (Malone, Palmer & Voigt, 2002, p.27-34):

1. Ask a Geographic Question
2. Acquire Geographic Resources
3. Explore Geographic Data
4. Analyze Geographic Information
5. Act Upon Geographic Knowledge

Lesson Five: Constructing a World Map with Layers

Lesson five, which is not yet developed, is meant to be a "how to" lesson so that students will be able to properly complete lesson six. While the focus of the course is to teach with GIS and not about GIS, a little GIS instruction was found necessary to ensure that students would adequately utilize the technology. Students should begin the lesson by examining a spreadsheet program and how to use it in order to understand how ArcView stores attribute information with spatial data. While many school boards have Microsoft Excel licensed, Corel's Quattro Pro is the Ministry Licensed spreadsheet program and therefore should

be utilized to teach students. Students should then explore the following tools in ArcView: the legend editor, the text tool, the information tool and the label tool. They should also understand how to work with tables and how to combine information from two different tables.

Lesson Six: Culminating Activity

Lesson six, which is also yet to be developed, asks students to show how a GIS could be used to solve a world problem. The course profile suggests that students might want to analyse issues such as economic indicators or natural disasters identification” (Public District School Board Writing Partnership, Spring 2002, p. 3). Understanding how GIS is used in problem solving situations is essential, and thus links back to lesson four should be provided in this lesson so that students can review the geographic inquiry model. While ArcCanada 2.0 is available to students as a source of data, other sources should also be mentioned in this lesson. The lesson will then provide some examples of world issues that students can solve or help to solve using a GIS.

Following the constructivist paradigm of education, lesson two and lesson six of unit two require students to use problem-solving skills.

To ensure that the content was reliable, only reputable textbooks and Websites were used as resources for information. These have been referenced directly on

the site so that the sources may be checked. Graphics taken from other Websites were linked back to those Websites.

GEOTECHNOLOGIES IN ACTION: THE ONLINE COURSE

Presenting content in an online format

In designing the course for online learning, attempts were made to utilize multimedia. Not only does this create a more dynamic site, it also responds to Howard Gardner's multiple intelligences as has been suggested in the literature. Flash animation was used in tutorials, such as in using WinZip, so students have a more interactive format from which to learn how to use specific software. Of the Flash animation used, only one incorporates sound; which is *How to Create a New Folder*, found in Lesson Two of Unit One (see figure 5.1). All the Flash animation should incorporate sound or text; but due to the time required to create a useable Flash animation, only one was created as a prototype.

Figure 5.1: Flash Tutorial – How to Create a New Folder

According to Freundschuch and Hellvik (1999), animation, which combines sounds, appeals to five out of the seven intelligences; these are: Kinaesthetic, Spatial, Musical, Logical-mathematical, Linguistic (see table 3.1). Using PowerPoint presentations, like the one found in lesson four of unit two, also provides animation.

Interactive quizzes, like the one found at the end of lesson two in unit two (see figure 5.2), provides students with immediate feedback on the knowledge they have retained. In this online format, students are able to return to the quiz several times to test their knowledge and only move on when they feel comfortable to do so. Interactivity such as this also corresponds to Gardner's multiple intelligences theory.

While use of multimedia can be an excellent tool for learning, it cannot be assumed that all students will be able to download the Flash player. It should also not be assumed that all students will have access to a high speed Internet, which will allow Flash movies to be played seamlessly. Noting this, an alternative html tutorial was built alongside the Flash tutorials.

Figure 5.2: Interactive Quiz

Design

Design elements suggested throughout the literature were used to develop this site. One of the main design features suggested in the human computer interaction literature is the use of “chunking”. Chunking involves dividing the different sections on the site into headings and subheadings; in the literature it has been argued that chunking helps users with reading comprehension

Frames are also heavily discouraged in the literature as they prevent bookmarking and make it more challenging to print a Web page. Frames also do

not appear the same on all browsers. Instead, a feature in DreamWeaver known as Layout was used. This feature provides the user the ability to divide a page into sections, thus making it easier to organize graphics and text. It also allows the Web user to easily bookmark a page or print a page.

Navigation

Navigation is an essential part of building an online course. As mentioned previously in Chapter Four, students can become lost and frustrated if navigation is not intuitive. To ensure that students understand their location in the learning environment, the same design style and fonts were used throughout the course. Background colour was used to help students orient themselves on the site. The orange area (see figure 5.3) is the area open to the public and is meant to provide information to students and their parents who are interested in the course. The green area (see figure 5.3) is the learning module section and it is only for students registered in the course. The use of these two colour schemes was employed to provide a visual clue to registered students as to which section of the Website they are located. A similar procedure is used in the Florida Virtual High School.

While not created in the prototype, the learning module section should require a password to enter. This is to provide a safe environment for students.

Figure 5.3: Geotechnologies in Action Colour Scheme

Orange area: Public Area

Green area: Learning Modules

There are many links to other Websites throughout the course and it was feared that students might become lost in another site by a following a direct link. To ensure that students will be able to find their way back to the original page, all external links open up in another window. Students are then simultaneously able to view information from another window while still being located in the learning environment. As mentioned previously in Chapter Four, Yu and Roh (2002) found in their research that the use of multi-windows eased confusion.

Other elements to provide a student with spatial information were used, such as employing graphic bound objects. In Units One and Two in the learning module section of the site (the green section) a happy face has been used so that students understand that this will take them to the Welcome Page (see Table 5.1). Graphics, like the Welcome Page graphic, were created in Photoshop 5.5

Table 5.1: Graphic Bound Images in Geotechnologies in Action		
Image	Description	Rationale
Happy Face	The Welcome section welcomes students to the course and contains valuable information about the course. To represent that this is a welcome area, a happy face graphic was created.
Textbook	The Course Outline Section provides students with a description of the course, the units, and information about plagiarism. A textbook graphic was used to indicate that this is important information.
Bookcase	A bookcase represents the resource section since most students are accustomed to having classroom resources in a bookcase or other shelving unit. The resource section contains useful Websites and a glossary of terms.
Two students	The Classmate Profiles section contains the student biographies. To represent this, a graphic of two students (a boy and a girl) was created.
A flying assignment	The Project Upload section is the tool students will use to send completed assignments to their teacher. To represent this, a "flying assignment" graphic was created.
Bulletin board pin	The Bulletin Board section is an area that allows students to post questions and comments to the class. A bulletin board pin graphic was used to represent this area.
A cup of coffee	The chat section is a tool where tools can communicate with each other synchronously. A graphic of a cup of coffee was used since having a cup of coffee it is often associated with "chatting".

Temporal context clues were also used, such as colour-coded links to show a visited link. For example in the learning modules section (green section) a non-visited link is white, while a *visited link* is green and an *active link* is purple. A visited link is a link that has already been explored and an active link is the colour a link changes to while it is being clicked. A link will remain active (in the learning module section purple) until that link has been closed, it will then turn to green.

Certain pages in the site had the browser's back and forward buttons removed. Some of the pages included back and forward buttons that were designed for this Website (see figure 5.4), other pages did not have any back or forward buttons indicating that the page did not lead anywhere else (see figure 5.5). This was done to ensure that students followed the intended path on the site and not become lost.

An important point to remember about navigation is that what the designer may see as intuitive, may not be viewed the same way by the user group. The only reliable way to test the navigation of an online environment is to have it used and evaluated by the intended group.

Figure 5.4: Page with backward and forward buttons

Figure 5.5 Page without backward or forward buttons

Browsers

The course was tested on two browsers: Netscape 7.0 and Internet Explorer 6.0 and found to function equally well on both of them. The one difference between

the browsers is that in Lesson 4, Unit Two: What is GIS, the PowerPoint Show opens up easily in Internet Explorer 6.0. When using Netscape 7.0, students must download the PowerPoint presentation to view it.

REDUCING DROP-OUT RATES

As mentioned previously in both Chapters Three and Four, online learning is faced with the issue of drop out rates that are significantly higher than those in a traditional classroom. One of the main reasons cited in the literature for dropping out of an online course is that students experience strong feelings of isolation in the course. Several techniques, as described in previous chapters have been incorporated to reduce these feelings of isolation, these are:

- A classmates profile so students will know there are others taking the course
- A chat option, so students will be able to contact each other and their teacher synchronously
- A bulletin board, so students can post questions and receive responses from fellow classmates and their teacher

Another way to ease feelings of isolation comes directly from the teacher of the course, which is to provide immediate feedback to student's emails or bulletin board posts.

Another reason cited in the literature for high drop out rates is that students can become overwhelmed in an online course. Taking a cue from Florida Virtual

School, students in this prototype are required to submit a calendar at the start of each module indicating when they will be working on the course (see Figure 5.6). While many of the students are mature enough to handle their own learning, some may need active encouragement. This is one method to motivate students to stay on track and help alleviate the drop out rate.

Figure 5.6: Instructions to submit a calendar

EVALUATION

The 24 evaluation benchmarks for online learning, developed by the Institute for Higher Education, suggests that all Websites should be evaluated according to a number of categories (see table 4.1). To ensure that this Website is useful it should be evaluated by skilled geography teachers, GIS educators, Web designers, the Ministry of Education and of course students. As this prototype

course was designed as a suggestion for an alternative means to present GIS education for high school students (which has been argued is lacking), the course is only a prototype. It therefore has not yet been evaluated.

GENERAL OBSERVATIONS

Time

While the extraordinary amount of time to create an online course was mentioned extensively throughout the literature, this was not fully appreciated by the author until the creation of this prototype. The number of hours dedicated to this small section is estimated to be around 250, which also included creating the lessons. Assuming that the teacher, through traditional classroom teaching, has already designed course material, this time could be reduced. Even with established and tested lessons, the amount of time to create a course should not be underestimated. According to Annette Levesque, online teacher with the Ottawa-Carleton District School Board, the minimum time to design a basic course (i.e. minimal to no interactivity) is 210 hours (Levesque, 2003).

Recognizing the amount of time necessary, it may be impossible for a teacher to have the course evaluated by the Ministry of Education, accomplished teachers, GIS educators and students as suggested. The course may have to rely on how traditional courses have always been evaluated, which is through the feedback provided by the students taking the course.

Expertise

As mentioned previously in Chapter Three, designing an online course often requires expertise that the ordinary teacher may not possess. The creation of a chat room was suggested in the prototype but was not created due to the author's lack of expertise in this area. A feature such as this one is essential to ensure social interaction in the course and should be included. A possible way to include the functionality of a chat room without creating one is to use one of the many free messenger programs available, such as Yahoo Messenger or Hotmail Messenger. These programs allow students to communicate synchronously, and have been used in online classrooms such as those taught by Annette Levesque (Levesque, 2002). When using a messenger program, students can only be contacted by those to whom they provide their messenger name. Hopefully they will limit this to those in the course. Students are also inundated by small commercial ads when using these programs, a situation a teacher may wish to consider before incorporating the program into their online course. It should also be noted that many schools have software installed on computers that will prevent students or teachers from downloading and installing programs such as Hotmail Messenger.

A bulletin board was also suggested in the prototype but not created because of the author's lack of expertise. Bulletin boards provide a means for students and teachers to post questions and answers that can be viewed by the whole class, providing increased learning opportunities. There are many free community sites

that could be used in place of a bulletin board, a popular and useful one is QuickTopic (<http://www.quicktopic.com>) which allows a administrator (i.e. the online teacher) to establish a community where invited participants can post bulletin board messages to each other. This tool would provide the same functionality as a bulletin board, plus its security measures would ensure that only those registered in the course would be able to view communication.

If a chat room or a bulletin board has been created for the course, it is essential that only registered students have access to the learning module portion of the program so that outsiders cannot view communication. Protecting students when using the Internet has become a policy of many school boards in North America as unauthorized Web users can contact students. For this prototype, a password was not created as the author did not have the expertise to develop a password only section. This may be done easily by the technical staff at the school board as was done in the case of Annette Levesque's online courses. However, it should not be assumed that all school boards have this type of resource.

Another part of the course that was not developed was the Assignment Upload area. This tool was deemed necessary because of the large file size of many ArcView projects, which makes it impossible to email through free email providers like Hotmail. Even with compressing a file size with WinZip, many students may find that they will be unable to email an assignment to a teacher since free email providers only allow files of small sizes to be sent (i.e. Hotmail

only allows sizes of up to 1024K). The author's lack of expertise prevented the Assignment Upload area from being developed. A solution to this problem comes from correspondence courses where finished material was mailed to the teacher. Students can save ArcView projects to a disk or CD-Rom, which can then be delivered to the online teacher through regular postal services.

A possible solution to the lack of teacher expertise in creating social interaction tools, passwords and assignment upload tools is to use a course management system such as Blackboard. Blackboard provides not only bulletin boards, chat rooms, password protection and assignment upload tools, but also provides teachers with tools to monitor student progress and to develop quizzes. However, Blackboard is not a free utility so it will not be an option for many teachers. It should be noted that Blackboard is available to teachers within many schools boards across the province as these boards have bought a license to use this environment. Some of the boards that have licensed Blackboard include the Ottawa-Carleton District School Board and the Ottawa-Carleton Catholic School Board.

A free solution to some of these problems of expertise comes from Macromedia. License holders of Marcomedia DreamWeaver MX, which includes all public elementary and secondary schools in Ontario, have access to free online courseware extensions. One useful extension includes the CourseBuilder

extension, which contains more than 40 pre-scripted quizzes, assessment templates and learning interactions.

Course Limitations

It has been argued throughout this thesis that teaching GIS online will ensure its availability to more high school students. Currently, there is a lack of GIS trained teachers in schools making GIS course like Geotechnologies in Action available at very few schools. Despite the intentions of this prototype to open up GIS education, it also limits the number of students who can take the course.

Unlike most online courses, this course is unavailable to students who wish to take it from home. Since the licensing agreement the Ontario Ministry of Education has with ESRI Canada does not allow students to install ArcView 3.x or ArcCanada 2.0 on their home computers, students who wish to take the course from home will have to purchase this software and data. Since the student price of ArcView 3.x is \$450CDN and the cost of ArcCanada 2.0 is \$99CDN (Kelly, 2002), it is not feasible to require students to purchase. Thus, this course is restricted to those students who can take it from their school where they will have access to ArcView and the data that is licensed by the Ontario Ministry of Education (i.e. ArcCanada 2.0) and their school board.

ESRI has developed a freeware version of ArcView called ArcExplorer which students could download onto their home computers. ArcExplorer does not

provide the same functionality as ArcView, but it does allow users to print maps, identify features, add themes, and perform basic statistical analysis. While ArcExplorer is an option it was not used in this prototype because of the desire to explore more advanced geographical concepts such as map projections, which are not possible to view in ArcExplorer.

Another way this course is limited in its availability to students is in the computer platform used. Throughout this thesis it was argued that online courses should be designed for both a Windows PC and a Macintosh computer, however since the author did not have access to a Macintosh this was not possible. Thus, this prototype course will only be available to those schools and students who have a Windows PC.

Copyright

An important issue that was not carefully examined in this thesis is the issue of copyright, especially copyright involving graphics from the Web. Use of graphics on educational work typically falls under the "Fair Use" rules for copyright, which allows educational sites to use copyright graphics as long as the graphical source is fully referenced. This was done throughout this project. However, copyright laws can be challenging to understand and a violation of copyright could shut down an online education course, thus limiting it for everyone.

But...

Despite some of these obvious limitations to the prototype, it does accomplish what it set out to do, which was to provide a workable alternative to the lack of GIS education in the traditional classroom because of inadequate computer hardware and lack of teacher training.

CONCLUSIONS AND DIRECTIONS FOR FUTHER RESEARCH

CONCLUSION

The central argument presented in this paper is that an in-school online GIS course has the potential to foster GIS knowledge in secondary school education. It has been argued that there is a current lack of GIS education in secondary schools, despite the pedagogical benefits to geographic education and, despite the demands by both post-secondary institutions and industry. This lack of GIS education is partly the result of the paucity of GIS trained teachers, which is exacerbated by the lack of training opportunities both in school boards and in faculties of education. Combined with this is the issue of inadequate computer hardware to properly facilitate a GIS education program. The author, while employed with the Ottawa-Carleton District School Board, often had to use inadequate computer labs to provide GIS instruction and this often resulted in students leaving the session with a negative view of GIS because of the unreliability of the computers used. GIS as an in-school online course can provide a possible solution to these problems by being able to reach students at schools that may not have teachers trained in GIS or labs available to teach GIS education to a whole classroom of students. Learning online can also provide a unique educational experience, which can be beneficial to many students.

Chapter One provided an overview of GIS education in North America – from its beginning at the post-secondary level to its current movement into the elementary and secondary school level. It explored the pedagogical benefits of GIS in the K-12 curriculum and the positive attitude teachers have towards GIS and its benefits. Despite this, Chapter One argued that GIS is not utilized to its full extent in the secondary school system. This chapter examined secondary school's ability to support GIS by examining the lack of current and incoming teachers trained in teaching about GIS and the lack of computer hardware available for many geography classes in schools. Based on a literature search, and the author's own experiences in the public school system, it was argued that the lack of trained teachers is a direct result of the lack of availability of training opportunities. This situation is unlikely to change in the near future, as there is also a lack of training in GIS for pre-service teachers at the faculties of education. The computer specifications required by a GIS are also at times too demanding for schools' budgets; and with the current environment of education cutbacks, the computer systems in many schools are unlikely to be upgraded. Finally, the chapter examined how GIS is being taught in secondary schools and found that it is also lacking. The majority of teachers rely on teaching about GIS instead of with GIS, negating many of the potential pedagogical benefits of using a GIS in a classroom. An in-school online GIS course has the ability to alleviate these problems by provided a highly trained GIS teacher to schools across the province

of Ontario and allowing schools to reserve adequate individual computers, rather than a classroom of inadequate computers, for students.

Chapter Two suggested that a potential way to ensure that GIS is taught in schools and be taught adequately, is to create an in-school online GIS course geared specifically for the high school student. To explore this issue, Chapter Two first examined the history of online learning and its use both in post-secondary and secondary education. It was argued in this section that since many secondary schools were successful in teaching teenagers in an online format, GIS education could be easily incorporated. To demonstrate this, Chapter Two first looked at the success post-secondary institutions were having with online GIS courses and then examined areas where high school students were taking online GIS courses; either at the post-secondary level or through ESRI's Virtual campus.

To establish that online education was a viable alternative to the traditional classroom, Chapter Three examined the advantages of learning online. Two potential benefits of online learning are that it responds to the various multiple intelligences outlined by Howard Gardner as well as Piaget's constructivism theory. Both of these theories are widely used in the development of educational resources. This chapter also examined the potential pitfalls of online education and argued that it is not a superior form of learning to the traditional classroom, but only an alternative. Finally, this chapter argued that while online learning and

traditional classroom learning generally have the same student success rates, there is evidence that students enjoy learning in an online environment better.

Chapter Four examined how an online course, and specifically an online GIS course, should be structured. It established that content should first be examined before the creation of the course to ensure that it is accurate, of good quality, current and reliable. It then examined Web guidelines and the need for a high quality and intuitive navigation systems. It argued that to create a successful course the site must follow proper guidelines as well as build a navigation system that limits frustration in students. Finally, the chapter examined ways in which a course can help prevent the high drop out rates normally associated with online courses. Solutions range from making a course socially interactive to ensuring the online instructor is one who is comfortable teaching in a student centred environment.

Chapter Five used the information from Chapter Four to develop a prototype course for the Ontario grade 12 course: Geotechnologies in Action. While this course is only a prototype it provides an example of the type of environment and lessons that could be developed for an online GIS course. While the course is not a perfect solution to the lack of GIS education in secondary schools, it does provide a possible alternative.

DIRECTIONS FOR FURTHER RESEARCH

The most obvious direction for further research is to fully develop a course or at least a unit, which can be tested by high school students. These students can evaluate the course to determine if the learning environment is intuitive and interactive, and most importantly whether or not they view taking an online GIS as an option. Teachers experienced in teaching GIS in geography classes should also examine the course to see if it adequately meets the curriculum expectations established by the Ministry of Education. They can also provide guidance in suggesting or improving lessons.

While the literature indicates that students perform equally well in both traditional and online classrooms, most of the research centres around university students and not high school students. The author was also unable to locate studies that compared student performance in an online GIS course to a traditional GIS course. Therefore, future research could also examine the performance of high school students learning the same GIS course both online and in the traditional classroom.

Another potential area for research to alleviate the lack of GIS trained teachers, while still providing GIS education to students is to examine learning modules that a classroom teacher can use with their students in a computer lab. Students would still learn online, but in a computer lab in the school where ArcView is

installed. In this situation, the classroom teacher would be present but would act as a facilitator rather than an instructor; therefore they would not have to be GIS trained. Modules like these could provide the solution to the lack of GIS trained teachers since the students would learn from the modules; it could also provide the classroom teacher with an opportunity to learn GIS with their students. The modules should also be developed so that they distance themselves from teaching about GIS and instead concentrate on teaching with GIS. One potential problem with this approach is that it does not solve the issue of obtaining computer hardware for a full classroom that allows for dynamic GIS learning, thus an in-school online course is still the superior option. However it does provide a potential solution to the lack of GIS education in secondary schools.

Research like this will hopefully help to increase the use of GIS education in secondary schools by pointing out possible solutions to the lack of GIS trained teachers and the lack of adequate or sufficient computer hardware.

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APPENDIX A

GEOGRAPHY CURRICULUM COURSE DESCRIPTIONS AT ONTARIO FACULTIES OF EDUCATION

BROCK UNIVERSITY:

EDUC 8Y29

Junior/Intermediate Social Studies, History and Geography

Teaching strategies appropriate to the Ontario curriculum. Key social science concepts; inquiry and communication skills to examine and understand communities, various heritages and citizenship. Emphasis on Canadian identity and democratic values. The study of history as a preparation for life in complex society. A focus on geography as the study of the interdependency of people and their environment.

Lectures, seminar, 2 hours alternate weeks.

(<http://www.brocku.ca/webcal/2002/undergrad/courses/EDUC.html>)

LAKEHEAD UNIVERSITY:

Education 4252

Curriculum and Instruction in Intermediate Geography

This course emphasizes the curricula, objectives and methods of teaching geography at the Intermediate level as they relate to the Ministry of Education Guidelines.

(<http://www.lakeheadu.ca/~calendar/current/programs/Faculty%20of%20Education/educusiecrse.html>)

Education 4263

Curriculum and Instruction in Geography (Intermediate-Senior)

This course emphasizes the curricula, objectives and methods of teaching geography at the Intermediate and Senior levels as they relate to the Ministry of Education Guidelines.

(<http://www.lakeheadu.ca/~calendar/current/programs/Faculty%20of%20Education/educusiecrse.html>)

LAURENTIAN UNIVERSITY

EDUC 4224 F

Enseignement des études sociales (moyen-intermédiaire)

Étude du programme et des approches pédagogiques (histoire, géographie, orientation, sciences familiales et affaires et commerce) aux

cycles moyen et intermédiaire, avec un accent particulier sur l'intégration de ces matières. (3h) 2 cr.
(<http://laurentian.ca/calendar/Education.pdf>)

EDUC 4329 F

Enseignement des études sociales (intermédiaire)

Étude du programme et des approches pédagogiques (histoire, géographie, orientation, sciences familiales et affaires et commerce) aux cycles moyen et intermédiaire, avec un accent particulier sur l'intégration de ces matières. Familiarisation de l'étudiante et de l'étudiant avec les outils pédagogiques, les cahiers d'activités et les ressources technologiques disponibles. (2h) 1.5 cr.
(<http://laurentian.ca/calendar/Education.pdf>)

NIPISSING UNIVERSITY

EDUC 4446E

Geography (Intermediate)

A critical study of the aims, scope and sequence of the Intermediate Division curriculum in Geography; analysis of Ministry guidelines; practicum (<http://www.nipissingu.ca/courses.cfm?itemid=1231>).

EDUC 4447E

Geography (Senior)

A critical study of the aims, scope and sequence of the Senior Division curriculum in Geography; analysis of Ministry guidelines; practicum (<http://www.nipissingu.ca/courses.cfm?itemid=1810>)

QUEEN'S UNIVERSITY

CURR 323

Geography (Intermediate-Senior)

Designed to prepare candidates to teach Geography at the Intermediate-Senior level grades (7-12). Using a geography context the program provides instruction in basic lesson planning, questioning techniques, field work methods, unit and course planning, evaluation as well as essential classroom management. Participants have an opportunity to develop and utilize a wide range of instructional materials plus interact with resource people who provide input and strategies related to specialized areas of the geography program. Familiarizes candidates with the current Ontario Ministry of Education guidelines in geography. A strong emphasis on the co-operative development and sharing of curriculum ideas and resources by candidates. Includes a lab component to provide hands-on experience in the use and application of computers and GIS software packages

appropriate for grades 1-12. Candidates with extensive prior experience in this area will be encouraged to develop classroom applications using GIS software. Lab fee \$30; learning materials \$10.
(<http://educ.queensu.ca/programs/pages/b.ed/courses/curr.html>)

UNIVERSITY OF OTTAWA

PED2141

Education in the Junior/Intermediate Division – Social Studies (History & Geography) and Health and Physical Education

Principles of curriculum design and evaluation as applied at the junior and intermediate division levels; analysis of the Ontario Curriculum and other Ministry documents; identification of specific skills and representative learning experiences in Social Studies, Health and Physical Education; preparation and utilization of resource materials.

(<http://www.uottawa.ca/academic/info/regist/crs/0203/coursesEN/PED.html#PED2141>)

PED4280

Instructional Strategies in Geography

Study of the scope, sequence, and application of appropriate cognitive and affective skills in intermediate-senior geography with exposure to methodologies applicable to basic, advanced, gifted, and integrated levels. Computer technology and geography programs will be utilized.

(<http://www.uottawa.ca/academic/info/regist/crs/0203/coursesEN/PED.html#PED4280>)

UNIVERSITY OF TORONTO

EDU1441

Geography Intermediate

This course facilitates the development of understandings and strategies for using the concepts and skills of geography to help students learn. Particular emphasis will be given to the learning needs of young adolescents. Candidates design and develop lessons and curriculum materials that are appropriate for diverse learners, and for teaching different kinds of geographic social science content, both across the curriculum and as a separate subject.

Prerequisites: Two full university courses in Geography.
(<http://ro.oise.utoronto.ca/>)

EDU1440

Geography Intermediate/Senior

This course facilitates the development of understandings and strategies

for using the concepts and skills of geography to help students learn. Candidates develop lessons and curriculum materials that are appropriate for diverse learners and for teaching different kinds of geographic social science content, including international and cross-cultural material. Consideration is given to issues related to current curriculum reform. The course includes inquiry models, field study, the application of technology in learning, feedback-oriented assessment, and a variety of instructional techniques. Assignments involve practical applications and critical reflection.

Prerequisites: Two full university courses in Geography.
(<http://ro.oise.utoronto.ca/>)

UNIVERSITY OF WESTERN ONTARIO

Geography in the Elementary School 24

An examination of current approaches and issues in social studies education as they relate to the teaching of geography as well as environmental, multicultural, global, peace and human rights education. Two hours per week, .5 credit
(http://http://www.edu.uwo.ca/preservice/coursedescript/reqc_primmore.html)

Teaching and Learning Theory in Intermediate/Senior Geography 32

Curriculum and instruction in secondary school geography. A focus on curriculum design and approaches to teaching and learning including use of geotechnologies. Examination of resources, assessment and evaluation procedures, and current issues in geography and social science education. Four hours per week, 1 credit
(http://www.edu.uwo.ca/preservice/coursedescript/reqC_intersenior.html)

YORK UNIVERSITY

ED/GEOG 3040

Teaching Geography in the Intermediate Division

Teaching Geography in the Intermediate Division. Methods and materials suited to the teaching of geography at the Intermediate level are examined along with study topics such as lesson and unit planning, evaluation and field trips. Practicum level: Intermediate Division.
(<http://courses.registrar.yorku.ca/main/detail.asp>)

ED/GEOG 3050

Teaching Geography in the Senior Division

Teaching Geography in the Senior Division. Building upon ED/GEOG 3040.04 and the Intermediate practicum, this course examines methods

and materials suitable for Senior Division geography. Practicum level:
Senior Division.
(<http://courses.registrar.yorku.ca/main/detail.asp>)

APPENDIX B

ONLINE COURSE FOR GEOTECHNOLOGIES IN ACTION

To view the prototype in-school online course, please visit:

<http://chat.carleton.ca/~sjbaulch>

Or, install the CD-ROM: Geotechnologies in Action and follow these instructions:

1. Open either Internet Explorer or Netscape Navigator
2. Open up the CD-ROM to view the files
3. Locate the file called index.html
4. Drag the file index.html to your browser
5. You should now be able to view the Website